The Dock and Harbour Authority

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Editorial Comments

Peniche and Fishery Harbours Generally.

From a Scottish commercial harbour of standing and historical renown, we turn our attention this month once more to foreign shores and devote our leading article to a study of the conditions and projected improvements at the fishery harbour of Peniche, on the West Coast of Portugal, particulars and plans of which have been kindly supplied by Engineer-Director Duarte Abecasis of the Portuguese Department of Hydraulic and Electrical Services, to whom we have previously been indebted for descriptive accounts of Portuguese ports and maritime activities.

Among the fishery harbours of the world, Peniche may not be particularly notable, but it is of interest as a typical case, representing a class of harbour of which there are many examples in the British Isles and elsewhere, modest in size yet demanding the full and earnest consideration of those responsible for the administration and upkeep of such undertakings. Fishing (by this we mean sea-fishing, not the gentle piscatorial art associated with the name of Isaac Walton) cannot be called a lucrative calling; indeed, as a matter of fact, it is one of the most trying and strenuous avocations, yielding a very modest livelihood to those who practice it and taking a toll of human life which is oftentimes appalling. The nation, therefore, is greatly indebted to the sturdy race of fishermen who brave manifold risks and dangers to gather in the harvest of the seas and bring it to the tables of the community at large—a task which, if not systematically and continuously performed would lead to a serious depletion of the national food supplies. It has to be remembered, moreover, that the fishery industry provides employment for thousands of people, who are not themselves fishermen, in the numerous processes connected with the sorting, packing, despatching, selling, preserving, canning and disposal of the catches in a variety of ways.

There is a further consideration of no little weight and importance as regards Great Britain and the Empire. The fisherman class provide the most eligible, and, we believe, the most numerous recruits for the Royal Navy. When the hazardous nature of the work performed by minesweepers, most of which are manned by the fishing fleets, is taken into account and the equally perilous duties of a multitude of light coasting craft similarly equipped, the nation has every reason to be proud of, as well as grateful to, its fishermen.

All this leads to the conclusion that too much can scarcely be done to stimulate and encourage the fishery industry in the country. Unfortunately, in many cases local resources are too meagre to admit of the execution of essential works so as to provide the requisite degree of shelter and harbourage at small fishing ports, and this being so, the nation is justifiably called upon to come to their financial assistance. The claim has been admitted and grants in aid have been made by the Ministry of Agriculture and Fisheries, who have dispensed considerable sums under this head since 1919, when a Small Harbours Committee was set up to deal with the matter. Prior to that date the Development and Road Improvement Funds Act, of 1909 was in operation and jointly up to the end of 1938, sums aggregating over £150,000, either as grants or loans, have been advanced for the improvement of fishery harbours in England and Wales.

The whole cost of the improvements at Peniche (which, when completed will have substantially exceeded £300,000), as also of all other Portuguese harbours is being borne by the Portuguese Government, the works being carried out by the Department of Hydraulic and Electrical Services under the Ministry of Public Works.

Lock Model Tests.

In this issue is reproduced the second of two papers, originally published in the Journal of the American Society of Civil Engineers, relating to an interesting series of observations made on the conformity in behaviour of model structures and their prototypes. In the present instance, the experiments dealt with hydraulic flow in the filling and emptying systems of lock chambers.

Models of three locks on the Tennessee River were studied, and in one case, in which the corresponding structures were geometrically similar and lock operation data in agreement, the results noted proved to be reasonably comformable. In the other two cases there were dissimilarities which made agreement less likely. Indeed, where geometrical similarity does not obtain, it was not to be expected that the operation of the structures would conform with much exactitude to the basic laws of similitude. The studies none the less are of great interest and yield valuable data for application to the design of structures of the type in question. Models can play an extremely useful part in elucidating problems which do not readily admit of exact calculation, and in confirming conjectural solutions based on insufficient data.

Editorial Comments—continued

Dock Planning for London.

Despite the warning, frequently re-iterated in authoritative quarters, that the United Nations have a long and difficult path to tread before hopes of final victory can be realised and the world settle down once more to an orderly system of existence, schemes for the re-organisation of all departments of public life and service continue to be propounded and discussed in ever-increasing volume. So long as this does not involve any slackening of the war effort, the awakening of interest in civic and political re-adjustment is perhaps to be encouraged, since it betokens active and vigorous thought. At the same time, it cannot be said that all re-planning is wholesome and beneficial. There is being exhibited at times an iconoclastic tendency to sweep away, in an impatient mood, many things of proved utility in the past, simply for the sake of substituting something novel, which is attractively presented in glowing, but often meretricious colours.

A striking instance of this is afforded by the recent promulgation by the Royal Institute of British Architects of a scheme for a drastic re-modelling of the docks system of the Port of London. One would have thought that such planning lay well outside the legitimate sphere of architecture and was peculiarly the province of the civil (maritime) engineer, but with a temerity which borders almost on effrontery, and, we understand, without inviting the views or assistance of the technical staff of the Port of London Authority, a committee of architects have outlined and exhibited a costly scheme of new dock construction which they imagine to be of sufficient value and importance to the maritime commercial world to justify the wholesale demolition of a large portion of the existing port accommodation (some of it recently modernised at considerable cost) in order to provide the elaborate ampitheatre required for the execution of their proposals.

Even if it were worth while doing so, exigencies of space do not permit of a detailed examination of the scheme, which is set out in the Second Interim Report of the London Regional Reconstruction Committee, extracts from which will be found on a later page. Briefly, it is suggested that the St. Katherine's, London, Surrey Commercial, West and East India and Millwall Docks should be " closed," the sites being allocated to other uses, and two entirely new sets of docks constructed: one on the Isle of Dogs and the other on the promontory on the South side of the river between Blackwall and Bugsby Reaches, the net result of which would be to replace 21 miles of existing quayage by only 10 miles of " ship quays." Seeing that in the past the quayage of the port has had to be repeatedly extended to meet the growing demands of trade (a process which it is to be hoped will continue in the future), this reduction of existing quayage by more than 50 per cent. hardly seems a procedure on the right lines. Moreover, it is accompanied by a substantial increase in impounded water area from 344.6 acres to 400 acres. Now, the ratio of water area to quayage length is very variable, being dependent on a number of considerations, but, generally speaking, having provided for the convenient manœuvring of ships in and out of their respective berths and for the accommodation of barges engaged in overside delivery, any excess of water area in the case of land-locked docks only represents needless expenditure on excavation, as also on pumping for impounding water, where, as at London, this course is practised. It has not to our knowledge been suggested in shipping circles that the present ratio of water area to quayage in the docks affected is inadequate, and there is no reason to think that this is the case. On these two general considerations, therefore, the architectural scheme shows to disadvantage.

But there are other objections. The proposed lay-out of the two new dock systems, as exhibited on the plan reproduced in this issue, is altogether too sketchy and amateurish for serious examination There is no apparent provision for new graving docks, though at least a round dozen of these are to be eliminated with the present systems. Perhaps this has been considered a detail too insignificant for the notice of the architectural dock planner, as also the provision and arrangement of transit sheds, quayside railway sidings and other trivial accessories. The report states that two main entrance locks are to be provided for each new dock area, but close scrutiny of the plan shows only rudimentary indications in one instance of what may pass for a lock chamber of anything approaching appropriate size, with another lock a vague possibility, both being so ill-defined and without signs of gates, as to leave a great deal to be imagined. If we do the designer an injustice, it must be attributed to the sketchiness of the plan, on the sole evidence of which it would appear that the majority of sea-going vessels are to be deprived of access to the new docks, except at or about the time of high water, with consequences in the way of delay and congestion that can well be imagined. But here our criticisms must stop for lack of space to pursue them further.

Ne sutor supra crepidam, says the old Latin proverb: " Let the shoemaker stick to his last." We are not in the least disposed to question the ability of architects to design cathedrals and other buildings of greater or less importance, but when it comes to the planning of dock systems to meet the commercial and shipping needs of a port, they should be reminded that this is not their business.

Sea Defence Works.

Following the publication in our March issue of the article on Design of Sea Walls, we are able, through the courtesy of *Civil Engineering* to reproduce in the present issue a subsequent article by the same author, Mr. Charles E. Fellows on the structural operations involved in such projects. The special hazards and difficulties attendant upon construction work in maritime situations renders an article of this kind of considerable interest and value to harbour and coastal engineers, and we are confident that the observations made by Mr. Fellows, arising out of his personal practical experience, will be found of great utility to those of our readers who are engaged in this class of work.

The Cinque Ports.

The announcement (recorded in this issue's Notes of the Month) of a movement at the Port of Sandwich for the revival, or confirmation of the mediæval privileges appertaining to the group of ports on the South and South-east Coast of England, known as the Cinque Ports, is of intriguing interest and invites attention to the origin and constitution of the confederation. Originally, in accordance with its name, an association of five ports: Hastings, Romney, Hythe, Dover and Sandwich, it was later extended to include Winchelsea and Rye, together with a number of other places as " limbs," or members, including Pevensey, Seaford, Lydd, Folkestone, Margate, Deal and Walmer. A number of these " ports " have, since the date of their inception, lost the qualification which justified the use of that term, and would now have difficulty in affording berthage accommodation for craft of the most moderate draught. Still, at one time, they were all ports *de facto*, in use as well as in name, and it devolved upon them up to the reign of Henry VII, to furnish the Crown with nearly all the ships and men necessary for the defence of the realm. Their duties and privileges were set out in a series of charters which go back to Saxon times. The oldest charter now on record is one dating from the 6th year of Edward I, but this makes reference to previous documents of the time of Edward the Confessor and William the Conqueror.

Of the rights and privileges so assigned in early days, many have become obsolete through the passage of time, and are now merely archaic terms, but some have survived, such as the Court of Shepway presided over by the Lord Warden, who is also Governor of Dover Castle and exercises maritime jurisdiction as Admiral of the ports.

Among the civic treasures of Sandwich, are two silver maces, five hundred years old, and a horn used six centuries ago for summoning the freemen of the town, as also a town crier's staff which is mentioned in documents of 1471.

Another curious relic of past history, given on the authority of the *Evening Standard*, is that the Mayor of Sandwich carries a blackthorn stick and wears a black robe in mourning for a former Mayor and other townspeople murdered a long time ago when a French force sacked the town. The date is not given, but records show that the town was repeatedly plundered by the French during the 15th Century.

It is to be hoped that the Cinque Ports will be able to retain, and even enhance, the dignity which they enjoyed in remote days of English maritime enterprise and adventure.

The Development of the Port of Peniche*

Projected Important Improvements to a Portuguese Fishery Harbour

By DUARTE ABECASIS, Director General of Hydraulic and Electrical Services. (Maritime Services Division), Lisbon.

Location

THE fishery port of Peniche lies about 100 kilometres to the north of Lisbon and also about 100 kilometres to the south of Figueira da Foz, another important port, both for commercial and fishery operations, on the West Coast of Portugal.

Storm waves attacking the breakwater, 17th January, 1939.

The harvest of fish during the last five years stands at about 17,000 tons, of the value of about £100,000 and has been utilised partly in preservation processes and partly in distribution, while fresh, throughout the central region of the north-eastern part of the country, as food for the population.

The harbour is sheltered from seas of the north-west by the Peninsula of Peniche and by the islands of the Archipelago of Berlengas, situated in the offing and obviously exposed to seas from the West and South-west.

In the neighbourhood there are other fishery grounds of major importance.

Coastal Regimen

The coastal regimen is determined by the following characteristics:

The dominating storms come from the W.N.W. and from the N.W., while those from the W. and S.W. are important. Waves from the N.W. to the W. circulate round the Peninsula, starting from Cape Carvoeiro, losing force and propagating themselves along the bay in the same direction, sensibly, as the waves from the S.W.

Sand drifts from the coast to the North, are arrested by the Peninsula of Peniche.

To the South of the embayment extends a long sandy beach with a moderate travel of sand drift along the beach from the South to North during storms in the South-westerly quadrant.

Movements of sand, transversal to the coast are of considerable importance.

The submarine slope is relatively steep and waves reach the port with appreciable violence.

Early Works

In order to improve in some degree the shelter conditions of the harbour, there was constructed between 1937 and 1939 a breakwater, 150 metres in extent, reaching at the pier head depths of 7 metres below lowest low water. This breakwater was constructed to the cross-section shown in Fig. 2. When nearing the end of its construction, a violent storm, with waves of from 6 to 7 metres amplitude, assaulted the work, dislocating the extremity of the superstructure of the body of the breakwater for about 0m.20, towards the interior, in relation to the pier head of the breakwater which remained undisturbed.

There was recognised, accordingly, the necessity of strengthening the breakwater in its outermost portion, and this was done as indicated in dark lines in Fig. 3. The widening of the superstructure was achieved by forming large cavities in the face of the interior parapet wall, constructing on the outer side a backing of masonry and filling the gap with cement concrete as can be seen in the photographic views accompanying this article. The internal berm was also reinforced for its support. The work thus strengthened has been assaulted by violent storms, among others that of the 17th December, 1942, of which a view can be seen in the illustration; these were waves from the W.S.W. of amplitudes which at Leixoes on the North coast of Portugal reached 8.5 metres, without causing any dislocation of the superstructure or of the protective blocks, and without producing more than slight cracks in the older portion or in that which constitutes the widening of the superstructure.

The total cost of the work, including the reinforcement, was about £50,000.

Proposed New Works

Since there is some silting in the recessed sheltered area of the port and as the degree of shelter may not be sufficient, it is further planned to construct a system of breakwaters reaching depths of —9 metres, which will resolve completely the problems of fishery craft accommodation at Peniche.

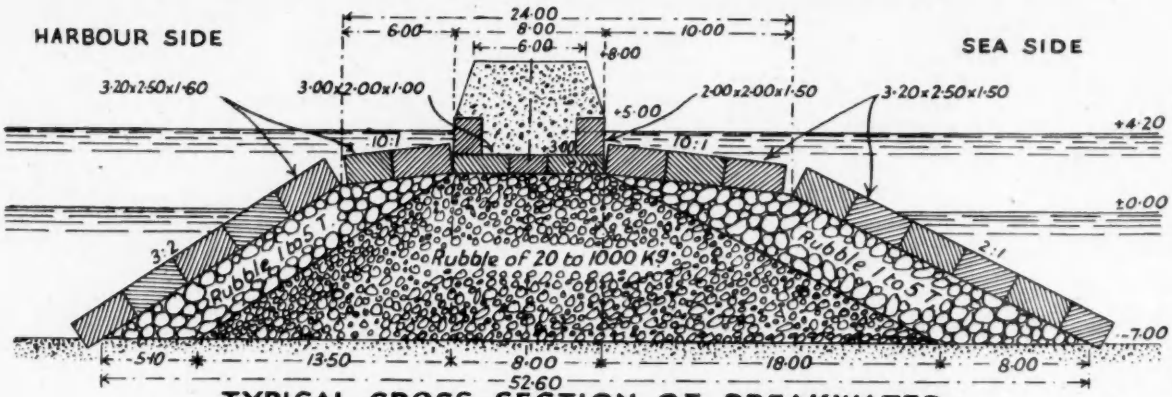
Storm waves at Peniche, 17th December, 1942.

The West breakwater will have 390 metres of length, including the 150 metres of the existing breakwater and will lie in a direction exposed to the S.W. Its form of construction is shown in the section attached to the general plan of port improvement.

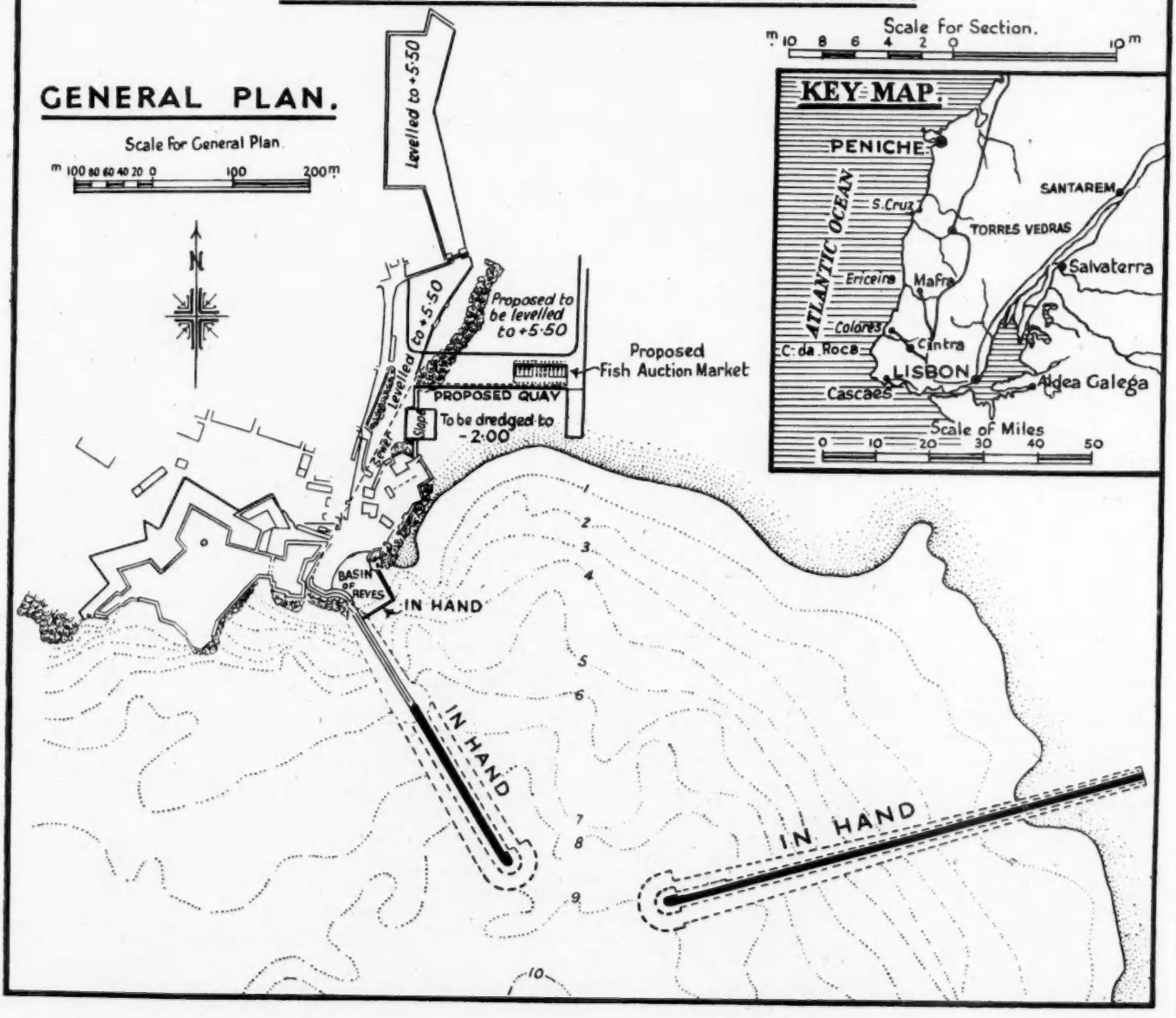
The Eastern mole will be 628 metres in length. As its exposure will be more favourable, its strength will be reduced from the pier head, which is equal to that of the Western mole, up to its connection with the shore line.

*Translated from the Portuguese.

HARBOUR OF PENICHE — PORTUGAL

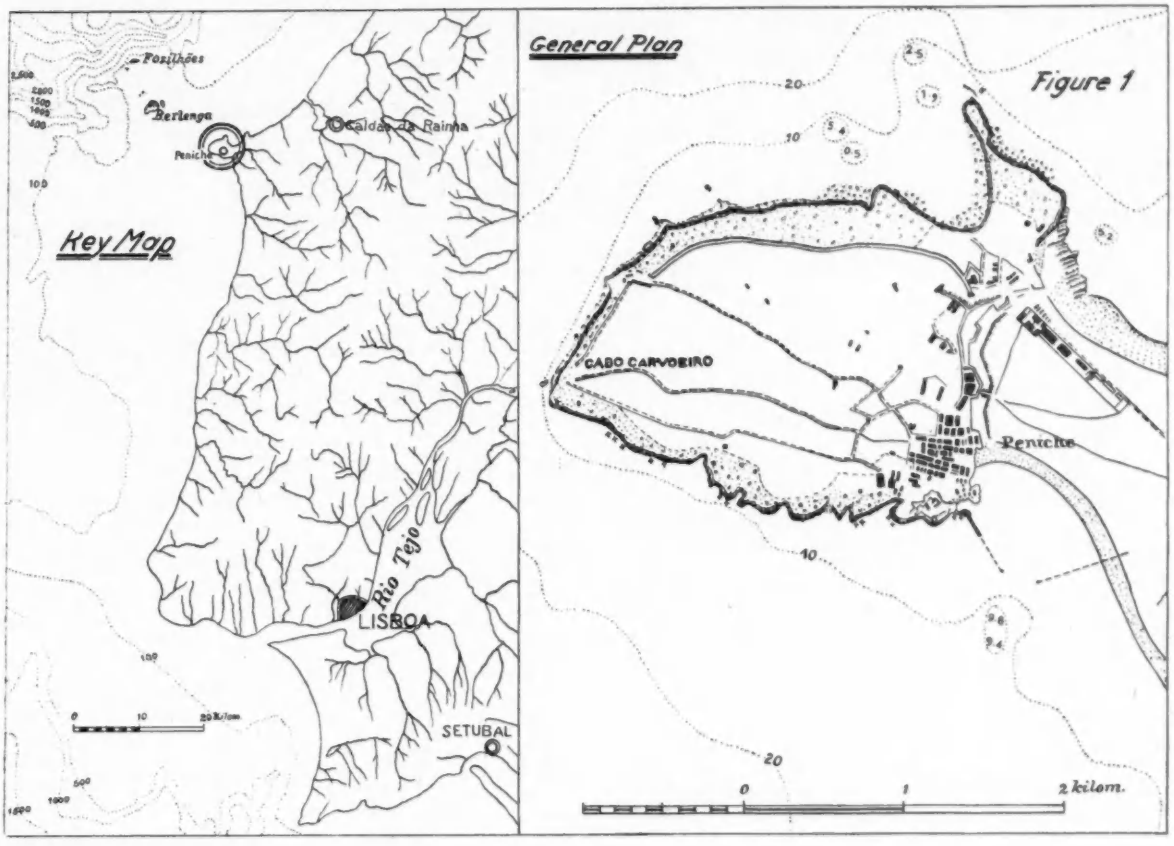


TYPICAL CROSS SECTION OF BREAKWATER.



Development of the Port of Peniche—continued

PENICHE HARBOUR



The entrance to the port will be 200 metres wide between the pier heads and will be directly open to storm waves.

There are foreseen interior works for the services of the fishery industry, comprising discharging berths and installations for treating, selling and despatching fish, means of repair and installations for the fitting out of barages, etc. These will evolve gradually. The estimated cost of the new works will amount to £260,000.

In extension of the foregoing article may be inserted the following extracts from the *Anuario dos Servicos Hidraulicos*, 1940, issued by that Department and prepared by the Engineer Director General, Duarte Abecasis.

View of protective blocks on exterior face of breakwater.

Governing Principles

The project for the development of the fishery harbour at Peniche, Portugal, is one of the items comprised in the general programme of works proposed to be carried out in Continental Portugal and its adjacent insular possessions. In the programme in question are laid down certain principles for application in the case of such harbour works, and these may be rendered as follows:

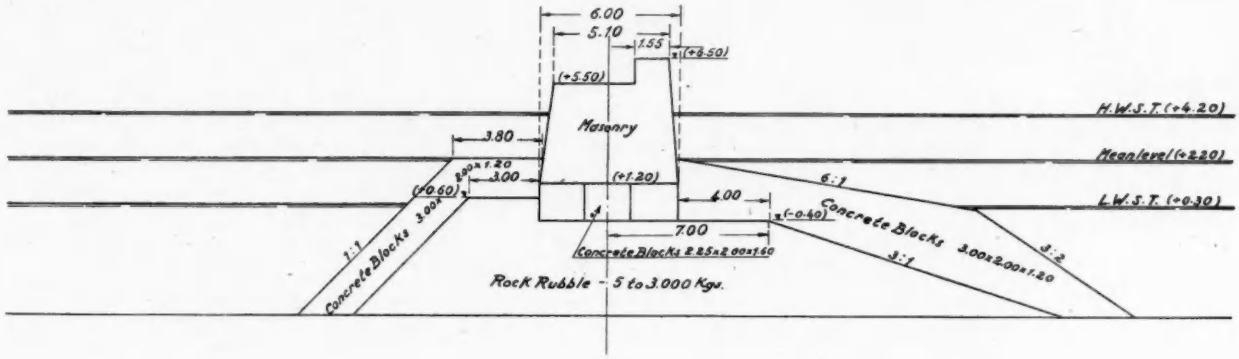
It is to be understood that, in a programme of protection works for the fishing industry, there must be included, on the one hand, the works necessary to assure convenient operating conditions under all circumstances at centres where are congregated thousands of fishermen who provide for others, many times in excess of their own numbers, occupation in allied industries and especially for those harbours properly designated fishery harbours; and in the second place, the works necessary to establish along the coastline at suitable distances apart (100 to 150 kilometres) a series of harbours of refuge where shelter can be obtained when vessels, in the course of their operations, are overtaken by storm under conditions in which it is impossible to regain their home bases. Such refuges would be beneficial not only to scattered fishing communities, but would provide means of employment in moderately-sized settlements.

For the solution of the problem which thus imposes itself, it is necessary, as the most obvious course, to arrange the location of the works in the more important fishery centres, either because they are to be found with few exceptions in situations provided by natural environment with shelter against definite storm directions,

PENICHE HARBOUR BREAKWATER.

Figure 2

Designed Cross Section



Head Cross Section

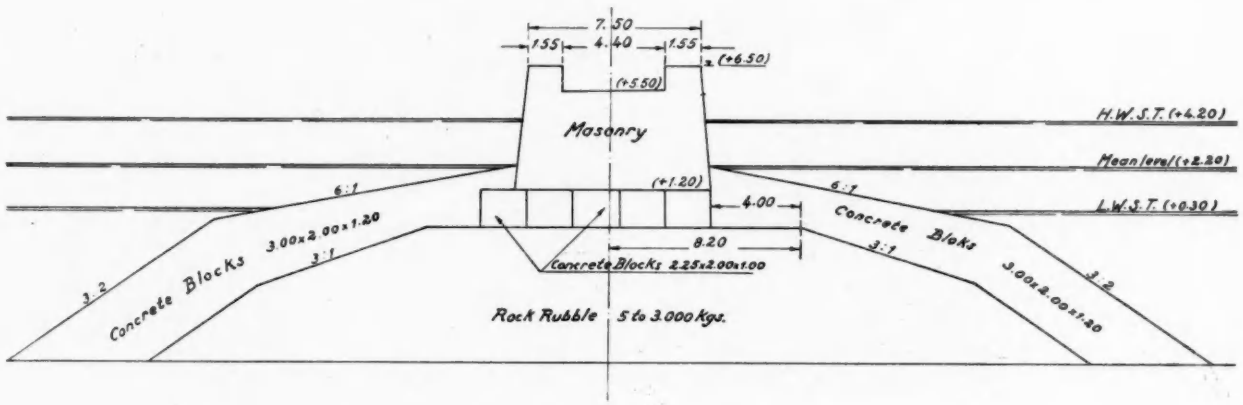
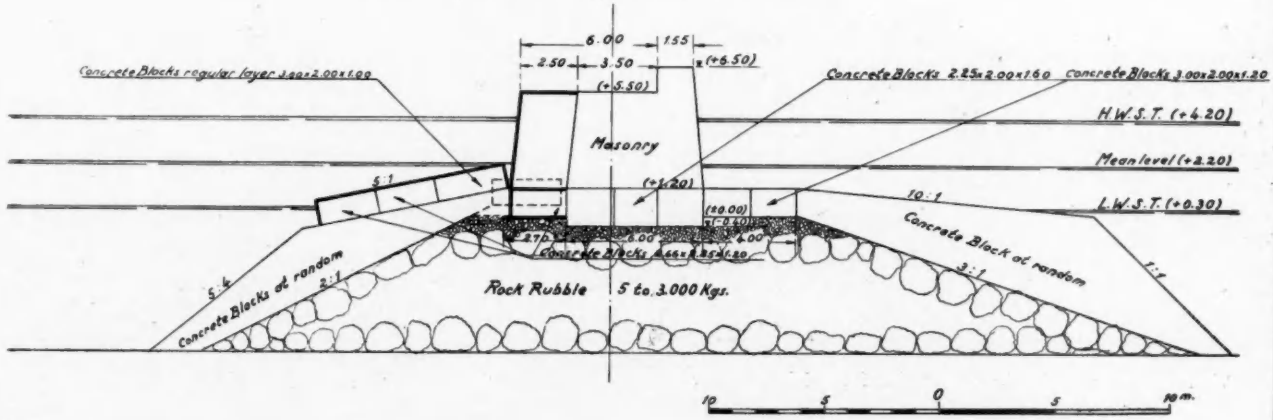


Figure 3

Cross Section as executed

After reinforcement

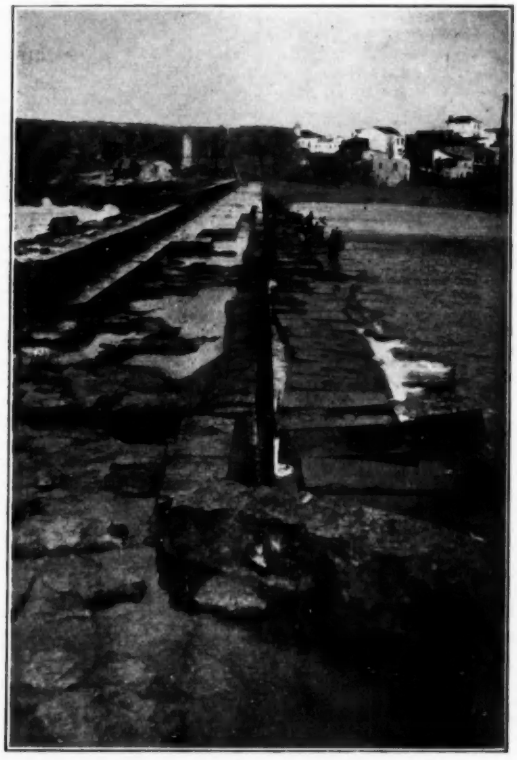


Development of the Port of Peniche—continued

which it is certain will assist in some degree in the achievement of a harbour of refuge, permitting it to be constructed under relatively economical conditions, or again, because these centres are always adjacent to the chief fishing grounds along the coast.

At Peniche, these conditions are met in the following manner: There are 1,800 registered fishermen of whom about 800 work in groups, 70 in well-equipped vessels and the remainder in small coasting fishing craft.

The cold storage industry maintains actually (in 1940) four factories in operation, three more in existence, one of which is equipped and the other two lacking the necessary equipment. They employ 700 workmen.



View of breakwater after storm damage. Note fissure adjacent to pierhead.

There is a natural shelter to North-west and partial shelter to the West, provided by the peninsula of Peniche and also by the Berlengas, Estelas, Farilhoes and other groups of islands and reefs.

The peninsula forms a barrier which arrests the movement of litoral drift from North to South. There are not to be found any deposits of serious importance in the direction South-North. It is adjacent to water of medium depths with land suitable for future utilisation.

Scheme of Internal Works

The scheme of internal works has been established on the following bases:

1. To correspond with the immediate requirement of exploitation in so far as local circumstances will permit them to be carried out without compromising the possible needs of future development.

2. A consideration of the immediate requirements with the actual movement of the port, admitting meanwhile that the movable net apparatus known as " penicheiras " at present in use may be partly replaced by apparatus called " American circles," identical with those in use at Leixoes.

3. Fishing by means of trawlers, a method which can reasonably be envisaged and the fishing for cod fish, are not therefore taken into consideration for the reason given in paragraph 1.

Upon these bases the scheme of interior works is limited to the solution of four fundamental questions:

1. Storage ground with access.
2. Berthage quays.
3. Fish auction market.
4. Repairs to craft.

The solution adopted is shown on the plan.

Proposed Ship Canal from New Orleans to the Gulf of Mexico

Shorter Route to Open Water

At a recent meeting of the Council of the New Orleans Association of Commerce, Louisiana, U.S.A., Mr. Lester F. Alexander, President of the Board of Port Commissioners, advocated the construction of a ship canal or channel, 40-ft. deep and approximately 75 miles long, " with no bends or elbow entrances," from the Industrial Canal at the City of New Orleans to deep water in the Gulf of Mexico, the canal terminating in its vicinity of Chandeleur Island.

Mr. Alexander traced the history of the Port of New Orleans and said that the commerce of the Port has increased in direct proportion to the improvements made in the ports' inland water system, dock facilities and channels to the sea. He pointed out that when peace comes a canal linking the Tennessee and Tombigbee rivers probably will be constructed, bringing points on the Mississippi River above Cairo, on the Ohio River above Paducah and on the Tennessee and Cumberland Rivers, closer to Mobile, which is only 35 miles of tide water to the sea.

Stressing the importance of a ship channel to Chandeleur Island, Mr. Alexander stated:

" Along the banks of this proposed canal is an unlimited area for slips and lateral canals on which could be constructed wharves and docks of concrete, at tide water level; the floor of these wharves to be at least 12-ft. below those now on the river front; these new wharves and docks could be served, both front and back, by a well-laid-out system of railroads-shipside warehouses where cargo may be received and stored for reshipment by rail or barge to interior points, eliminating much of the present costs of trucking and storing in city warehouses, with the consequent rehandling when shipment is made to final destination—too much cost and so unnecessary!

" A shipside foreign trade zone—a foreign trade zone in reality and not in name only—a zone performing its functions as the law intended and on a profitable basis!

A Great Navy Yard

" Terminals to fit all requirements could be constructed at minimum cost. Location was available for a United States Navy Yard, second to none in the United States, and perhaps, most important of all, a great naval graving dock, so urgently needed to-day. It is impossible to construct these facilities on the banks of the river with over 20-ft. variation in water levels."

Mr. Alexander said that construction of the proposed canal would result in a saving of 50 per cent. of present-day costs in bringing a ship from the Gulf to New Orleans, discharging its cargo, reloading and returning to deep water in the Gulf.

Construction would cost approximately $199,000,000, he estimated, and would provide employment for 7,000 or 8,000 men for a period of 10 years. Mr. Alexander also suggested that a highway to Chandeleur Island could be built on the fill created by the canal excavation and Chandeleur Island could " soon become a second Miami Beach."

Speaking of the present-day port, Mr. Alexander said the Dock Board's surplus increased from $610,000 in 1911 to $5,700,000 in 1940, and that as of February 28th, 1943, the Board's surplus was $8,100,000. He pointed out that the improvement during the past three years was " made during war conditions with consequent loss of tonnage and other forms of revenue."

*Trawling and the Stocks of Fish**

By E. S. RUSSELL, O.B.E., M.A., D.Sc., P.L.S.,
Director of Fishery Investigations, Ministry of Agriculture and Fisheries.

(Concluded from page 47)

Haddock in Icelandic Waters

That the stock of haddock in Icelandic waters is being over-fished can also be demonstrated conclusively. In this case there is direct evidence of an increase in the amount of fishing, which has resulted in a decrease in the average landing per day's absence and a decrease in total yield. The data available are set out in graphic form in Figs. 2 and 3.

Fig. 2 shows for the post-war years the amount of fishing by English steam trawlers—in 1919 to 1924 the number of days' absence from port, in 1924 to 1937 the more accurate measure of the number of hours actual fishing. It will be seen that there has been a notable increase in the amount of fishing since 1925, the number of hours being almost doubled by 1937. As English trawlers were responsible for the bulk of the total catch in these waters by all nations, we may safely conclude that the total intensity of fishing has greatly increased up to 1937. When we remember that the V.-D. trawl, introduced from 1923 onwards, increased catching power by some 30 per cent., if not more, this conclusion is reinforced.

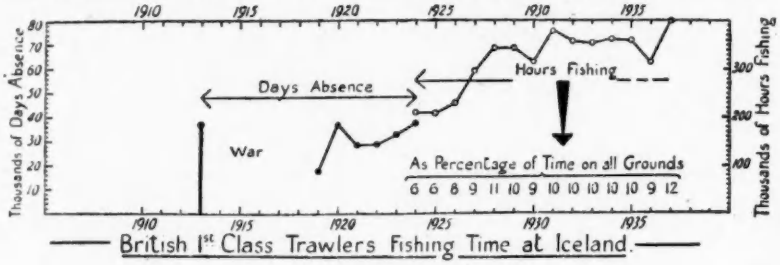


Fig. 2.

In Fig. 3 we see in the top line the total landings of haddock from Icelandic waters from 1905 to 1935, and below, the landing per day's absence by English steam trawlers during the same period, with the exception of the war years. In 1919, when fishing got going again after the war, the total yield was rather above the pre-war standard, and it is noteworthy that the landing per day's absence was very high indeed. In 1920, the total yield reached a high level, but it is of interest to note that the landing per day's absence fell to 15.0 cwt., as compared with its maximum in 1919 of 21.4 cwt. The amount of fishing increased considerably in 1920, making heavier inroads of the stock accumulated in the war years. You will remember that the same sequence of events occurred in the North Sea haddock fishery immediately after the war.

During the period 1921 to 1926 the total yield remained fairly stable at a level somewhat above that of pre-war years, but the landing per day's absence fell steadily till 1925. Then it showed a recovery in 1926 and 1927, the total landings shooting up in 1927 and 1928 to a record height. This improvement in yield may be attributed mainly to a marked increase in the amount of fishing, as is indicated in Fig 2, and to the coming into operation of the V.-D. trawl. The landing per day's absence, which shows a minor peak in 1927, thereafter fell steadily to reach a stable value of about 5 cwt. in the period 1933 to 1937. This was accompanied by a very rapid fall in total yield, which reached and remained at a low level in the years 1933 to 1935.

Now, as we have seen, during this whole period, from 1926 onward, the intensity of fishing was on the up-grade. This increased fishing led to an impoverishment of the stock, and to a very great falling off in the total yield. The stock was being definitely over-fished.

*Paper read before the Royal Society of Arts, January, 1943, and reproduced, by permission, from the Society's Journal.

Stocks of Cod and other Demersal Fish

The same thing is true of the stocks of cod and plaice in the North Sea, of plaice and halibut in Icelandic waters, and of hake on the Atlantic slope west of the British Isles. In all these fisheries the growing intensity of fishing has had as its consequence a diminished catch. The only important demersal fishery in which over-fishing has not been demonstrated is the great cod fishery in the far north, where there has been a considerable increase in the magnitude and range of the stock, due to a favourable change in the hydrographical conditions affecting the fish. From all the evidence available, only a small part of which I have given here, the general conclusion may be drawn that, with the exception just mentioned, the stocks of the principal demersal fish were being definitely over-fished before the present war, and that accordingly a reduction in the intensity of fishing was called for. With less fishing, less expenditure of material and effort, a greater catch could have been got, and the stocks maintained at a higher and more profitable level.

Decrease in Total Yields

The reason why excessive fishing brings about a decrease in total yields is not far to seek. If fishing is very intensive, the mortality rate due to fishing is very high, and the fish are not given time to grow up; the annual upgrowth of the stock, which is mostly removed as catch, is kept well below its possible maximum. If the rate of fishing mortality is reduced, more fish survive to grow up, and there are more and bigger fish to be caught. It is not difficult to demonstrate mathematically that there must exist an optimum rate of fishing, at which the maximum steady yield can be obtained, subject, of course, to such natural fluctuations in the supply of young brood as occur in most species. I shall not attempt this demonstration here. Instead, I would call your attention to Fig. 4, first published by my colleague Michael Graham (4), in which the contrast between heavy fishing and light fishing is well brought out. On the left-hand side we have the effects of intensive fishing clearly depicted; the stock becomes rapidly reduced, so that very few large fish survive in their fourth year; the catch is predominantly of small fish.

On the right-hand side we see the effects of a fishing rate only one-third as intense. The inroads on the stock are much less, so that a good proportion of the fish grow up to adult size. The catch contains far fewer small fish, but rather more large fish, and adding up the weights, we find that with one-third the effort, just as much weight of fish is caught as in the very intensive fishery shown on the left. The diagram must, of course, be taken as illustrative only, but the principle is perfectly clear.

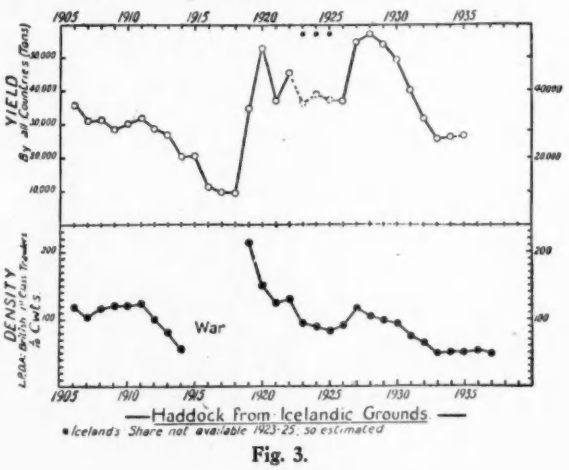


Fig. 3.

Conclusion

In conclusion, let us consider briefly what can be done about over-fishing. There is no doubt that, before the present war, over-fishing was widespread, and the need for some form of regulation and control was urgent. A beginning was made in 1933 with the introduction by the British Government of mesh regulations and

Trawling and the Stocks of Fish—continued

size limits for the principal demersal fish. A somewhat large size of mesh than was commonly in use was prescribed for trawl nets, enabling a larger proportion of undersized " round fish " to escape capture. This was all to the good, and many of the European nations followed our lead, an International Convention being signed in 1937 to give effect to regulations similar to the British. But the saving of small fish effected by these measures was not very great, and they hardly touched the major problem of over-fishing. It is certainly important to reduce the great wastage of under-sized fish which are caught by the trawl and thrown overboard as too small to bring to market, and the best way to do this is to increase further the size of mesh that may be used. But there is, obviously, only one radical method of dealing with over-fishing, and that is to reduce the intensity of fishing. The remedy for over-fishing is, quite simply, less fishing.

This remedy has been applied with striking success in one great fishery in the Pacific, the line-fishery for halibut which is prosecuted

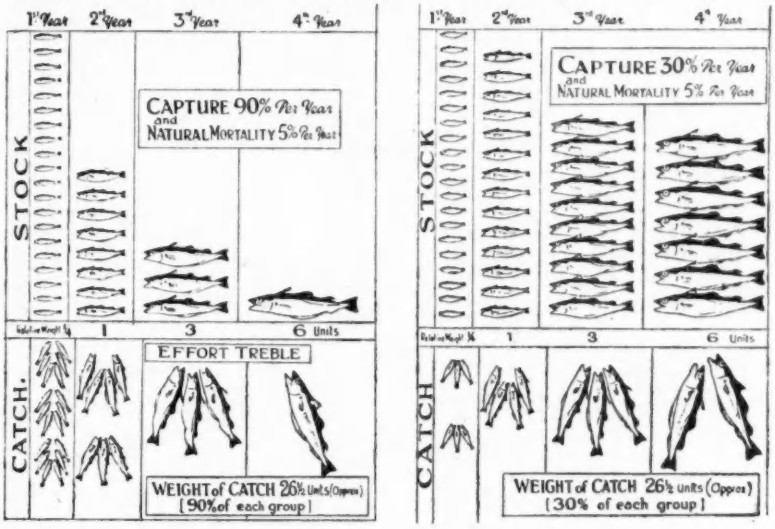


Fig. 4.

by Canada and the United from Alaska to Oregon (5). The stock had become greatly depleted through over-fishing; the catch per unit of effort and the total yield were falling, when a joint Commission of the two countries took the matter in hand. A Convention was signed limiting the total amount of halibut that could be landed each year, the quota being fixed at a level which enabled the stock to recover and build itself up. The results exceeded expectations; on the southern banks the abundance of the halibut increased by some 60 per cent., and the fishermen caught their quota in five months instead of nine. It is estimated that the earnings of the halibut fishermen are now one million dollars a year greater than they would have been without this wise regulation of the fishery.

During the present war, the intensity of trawling has, of course, for obvious reasons, been very much reduced. I can quote no figures, but it is no secret that the number of British trawlers now engaged in fishing is very much smaller than in normal times. The inevitable result of this reduction in fishing will be an increase in the density of the stocks, just as it was in the last war. There will therefore be, at the end of this war, a valuable opportunity offered to us, of so adjusting the amount of fishing, by international agreement, as to avoid the danger of waste of over-fishing, and maintain the stocks of fish at a more profitable level than was the case before the war.

Let us hope that this opportunity for effective action will not be let slip.

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Discussion

The Chairman said: I am sure we are very much obliged to Dr. Russell for the brilliant picture he has painted of a subject that must be of interest to every one of us. He has described very graphically what happened as a result of the lack of control over fishing in the years between the two wars.

Now that we are again at war fish is in short supply, as I suppose we all know. Many people, however, do not realise, I think, that that short supply is not due to any shortcomings of the fishing industry but to the fact that a very large proportion of the trawlers had been taken for naval work, and many of those that are left are unfit to travel very far. In addition to that, many of the nearer grounds, where they could go, are closed to them for strategic reasons. One result of that has been that there has had to be a considerable change in the ports at which fish is landed. Some ports are now having to deal with much greater quantities than they dealt with in peace time, and this, coupled with the difficulties of railway transport, inevitably complicates the problem of distribution. That problem is one for my colleague, Lord Woolton (I am responsible only for production), and when people complain about short supply I think they ought in fairness to remember the difficulties with which Lord Woolton is faced. At the same time I think it is worth noting that the actual supply of fish landed is considerably larger than anyone could reasonably expect, considering the difficulties.

Despite all the handicaps which I have referred, the fisherman is still carrying out his task with unexampled courage and enterprise. Those who are still engaged in fishing as well as those who are now serving in minesweepers and the trawlers which have been taken for various naval purposes are suffering considerable losses by enemy action, and I think we ought all to be very thankful for the fisherman's steadfastness and courage.

One of the results of the war will undoubtedly be, as Dr. Russell has said, a considerable increase in the amount of fish available for catching immediately after the war. Nature is seeing to that, without any help from man. I think you will agree with me, after hearing Dr. Russell's paper, that after the war we must see that some control is exercised and that the over-fishing which took place after the last war is not indulged in again. We are now engaged, as a matter of fact, in consultation with the industry and with our Allies, in trying to see whether we can devise a suitable system which will prevent over-fishing after the war. That must, I think, be one of our main objectives, and obviously it is a matter of vital interest for the prosperity not only of our own fishing industry, but of the fishing industry of other nations bordering the North Sea.

Mr. D. Gibson (of the *Daily Telegraph*) asked: Is the system which Dr. Russell says the Americans and Canadians have used with good results the sort of ideal system that we also should adopt?

Dr. Russell replied: That is a rather difficult question to answer. Under that system a quota was fixed and only a certain quantity of halibut could be landed. It is very difficult to say whether that would be the best method to adopt in our own case, which is a much more complicated one.

Mr. J. C. Ward (Milford Steam Trawling Company) said: Undoubtedly this war has proved to us that over-fishing is a menace, because we are catching more fish now at certain times of the year with far fewer vessels. That brings us back to the position before the war, when the fishing industry was in very dire straits. Bigger and bigger ships were built to catch more and more fish, which drugged the market at times, and I feel very strongly that we have to draw a mean line, so that we can catch, if necessary, the same

Trawling and the Stocks of Fish—continued

amount of fish at a lower cost. In that connection we want research, and I think that is one of the crying needs of the industry. We all have ideas on the subject. The Pareja type of fishing in Spain produces large quantities of fish. It is said that one cannot catch fish by the tail, and that is perfectly true; if one tows fast one does not catch any more fish. The ordinary trawl gear is heavy, with heavy boards. In the Spanish system two vessels are used, to keep the gear apart, and there is a very light net; the vessels go along slowly, with very little power, and they catch a very large quantity of big fish, leaving the small ones behind. I am convinced, as are some of my colleagues, that we could adapt the Spanish type of fishing so that we could work it from a single ship.

I feel very strongly that after the war we must have some sort of research. We at Milford propose to help ourselves, but I should like to tell Mr. Hudson that we propose to ask for help as well. We are quite convinced that we can produce something good. We are starting in a small way, but we do want help, and I am quite convinced that if we have research we can produce the fish that are wanted at a lower cost. I would suggest that some of the Excess Profits Tax that we are paying now might be set aside to provide a research fund after the war.

Dr. Russell replied: I am very glad to hear that you are taking so much interest in research in Milford Haven. Possibly that is due to the missionary efforts of my colleague Mr. Hickling.

Mr. Ward: Yes.

Dr. Russell: The Ministry will be very glad indeed to take advantage of that desirable research and to provide any help we can in the way of lending staff or giving advice.

Mr. F. Parkes (Fleetwood) said: I speak as a producer. Unfortunately I came into this meeting very late, but I arrived in time to hear a most important statement from Dr. Russell about the mesh of the net In my opinion (and I speak with a lifetime's experience) increasing the mesh of the net is the only remedy that we have to preserve our fisheries. We had an Agreement with the other countries bordering on the North Sea, but they did not respect that Agreement. I know of my own knowledge that they used to trawl for fish all the year round with what they called a herring net, a net with a very small mesh, and when they were challenged about fishing with that net they always said they were trawling for herrings, even at a season of the year when they knew there was not a herring to be caught. That was their " get-out." We do not want any " get-outs " like that if we have a new agreement with our neighbours bordering on the North Sea. We want a hard and fast arrangement, with international control, to ensure that it is respected. We in this country are well looked after by the Chairman's Department in that respect and we are not allowed to transgress in regard to the size of the mesh, and so on, but when we find our neighbours on the other side of the North Sea and across the English Channel catching small fish that ought to pass through the mesh and provide the fish of the future it is rather discouraging and disheartening. I strongly recommend Dr. Russell's Committee to pay great attention to this particular item, because I am sure he is working on the right lines in regard to that side of the matter.

Mr. H. E. Rees (Milford) said: In the first place I should like to express, on behalf of my port, our thanks to the Royal Society of Arts for allowing us to attend this meeting, and, secondly, I should like to thank Dr. Russell for his paper. Most of us in the industry have read Dr. Russell's book, and we know that what he has told us to-day are just stark facts that cannot be denied. In the early days of trawling the scientist did not have very much to do with it, and it was probably for that reason that the industry got into the position it occupied just before the war, when it was in a state of semi-bankruptcy.

Wrapped up with all that Dr. Russell has told us to-day is the fact that boats were run to pay and the trawler owner was not so very much concerned with whether the haddocks he caught were 6-in. or 12-in. long. But it has been proved to us—and to-day I think we are alive to the fact—that if we slaughter all the young fish in the sea the time will come when there will be nothing for us to catch. That was proved after the last war, when we had very heavy catches of fish, which were caught in a comparatively few years, and we in the industry to-day know that at the present time the sea is stocked very heavily with fish, which will be ours after the war. Mr. Ward has said that as a port we are interested —and I hope we shall continue to be interested—in the subject of research. We are fortunate in having Mr. Hickling with us, and anything in the way of research that we can do we hope to do.

One of the most pleasing things to me is that the Minister of Agriculture and Fisheries is in the Chair to-day, because he will be at the head of our industry, and whether we rise or fall after the war he will be with us. Therefore I am very glad to see him here to-day.

I should like to have Dr. Russell's views on how he proposes to deal with the foreigner. I suppose that the majority of those here to-day really came to find out what had happened to the fish in the fishmongers' shops rather than to the fish in the sea, and they may have been disappointed, but Dr. Russell knows that one of our great difficulties with regard to the mesh question was the foreigner. We have an excellent lot of men who go to sea in our trawlers, but they are not angels; they are as human as the rest of us, and if they fish on our grounds alongside a Frenchman or a Dutchman or a Belgian who has a net with a smaller mesh than theirs they ask us for a similar net, and if we do not give it to them they fix it up for themselves when they go to sea. If there was an international mesh it would be very much easier to prevent the catching of small fish. I foresee a great deal of trouble if on our grounds just outside our port, our men go out with nets of a certain size mesh and meet Belgians and Frenchmen with a net of a much smaller mesh.

The Chairman said: I do not think it is altogether fair to Dr. Russell to ask him to answer that specific question. The matter is really one for he Government and it will be part of our task to see that, if possible, suitable international arrangements are made.

A vote of thanks to the lecturer, proposed by the President, was carried unanimously, and the meeting then terminated.

The Port of Durban and its Future.

In a recent speech, the Natal Administrator, Mr. G. Heaton Nicholls, said that Durban, the largest harbour of the Union of South Africa and the biggest seaport on the eastern shore of the African continent, was destined to become the new Singapore of the Indian Ocean. In embarking upon post-war works and reconstruction it was important to remember that it was essentially a seaport. The duty of looking after the harbour was at present shared by the Railways and Harbours Administration and the British Admiralty. The city's potentialities as a great naval base meant a fourfold increase in harbourage. The development must conform with the civic plan.

Development of South African Ports.

Estimates of expenditure totalling £5,590,259 on capital and betterment works of the South African Railways and Harbours for the current financial year have been tabled in the Union House of Assembly.

Provision for the development of the ports figures prominently in the estimates. A sum of £700,000 is provided for the new graving dock now being constructed in Table Bay Harbour, Cape Town, on which the estimated expenditure so far has been £275,393. The total cost of this project is estimated at over £2,000,000. A further £100,000 is provided for a graving dock at Buffalo Harbour, East London, on which £10,000 is already estimated to have been spent. The total estimated cost is £850,000. Additional provision for development of Salisbury Island, Durban, totals £373,156, and additional provision for deep-water berths at Durban totals £196,155. An amount of £25,500 is also provided for a landing and take-off area for flying boats in Durban Harbour.

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Notes of the Month

Llanelly Harbour Appointment.

Mr. Edward John Davies, of Langstone, Mon., assistant yard master under the Great Western Railway, at Newport, has been promoted to the position of general superintendent and docks manager at Llanelly Harbour.

Honour for Port Chairman.

Included in the recent Birthday Honours list was the name of Sir Thomas Howard Elderton, chairman of the Calcutta Port Commissioners, who has been awarded the K.C.I.E.

Honour for Member of Harbour Board.

Mr. Henry Main, J.P., a member of the Dundee Harbour Trust and Regional Director (Merchant Shipbuilding and Repairs) East of Scotland, has been made a C.B.E. (Civil Division).

Appointment of Welfare Officer at African Port.

Mr. W. J. R. Simpson, a native of Belfast, has been appointed Port Welfare Officer, at Lagos and manager of the Wharf Inn, Apapa, Nigeria, where he will have important duties in supervising the general welfare of seamen of all nationalities visiting the port in question.

Business Announcement.

Messrs. Charles Brand and Son, Ltd., Civil Engineering Contractors, 25-27, Charles II Street, Haymarket, London, S.W.1, announce that they have appointed Mr. W. J. H. Rennie, M.Inst.C.E., a director of the firm.

Falkenberg Harbour Improvement.

A scheme for improving and modernising the Swedish Port of Falkenberg, put forward by the Harbour Board, and estimated to cost a total of 2,563,000 kroner, has been approved by the Finance Committee of the local Council. The scheme provides for the entrance channel to be given a depth of 7 metres, and the items include: Dredging of channel, 1,166,000 kr.; provision of sand catchers, 152,000 kr.; construction of stone breakwater, 296,000 kr.; 12 reinforced concrete caissons, 757,000 kr.; two pierheads, 127,000 kr.; and lights, 40,000 kr.

Greenock Harbour Development.

The Greenock Harbour Trustees have under consideration a scheme of post-war development of considerable magnitude, which if carried into effect will have considerable influence in raising the status of the port. The scheme to be undertaken in co-operation with other interested bodies, including the Admiralty, provides for the construction of a naval base with accommodation for capital ships and ocean liners, as well as for sea and air planes, and involves the demolition of several of the existing docks and a partial reconstruction of the James Watt Dock. Various other alterations, including the adjustment of the navigable channel in the river and the re-modelling of the railway facilities of the port, are included in a programme of works estimated to cost several million pounds.

Mombasa Port Traffic.

According to the *Crown Colonist*, more than 2,100,000 tons of cargo were handled last year at the Port of Mombasa, Kenya, as compared with 1,261,000 tons in 1939, obviously as the outcome of war-time operations. Referring to the two new deep-water berths now being constructed at the Port, the general manager of the Kenya and Uganda Railways and Harbours Administration has stated that while their immediate purpose is to meet war-time requirements, they are part of a general plan of harbour development which was decided upon some years ago, and which aims at making Mombasa one of the best equipped ports for receiving all kinds of shipping and cargo on the East Coast of Africa. It is expected that the first of the berths will be in service this month, while the second should be ready for use shortly afterwards. The cost of the new berths to the Railways and Harbours Administration is estimated at £410,300.

Distinction for Port Official.

Mr. R. W. Hendry, Port Manager, Halifax, N.S., has been awarded the M.B.E. (Civil Division).

Association of Consulting Engineers.

Mr. Sydney B. Donkin, M.Inst.C.E., M.I.Mech.E., M.I.E.E., has been elected chairman of the Association of Consulting Engineers for the year 1943-4.

Institute of Transport.

Among recent elections to full membership of the Institute of Transport (M.Inst.T) is that of Sir J. Douglas Ritchie, M.C., general manager of the Port of London Authority.

Port of London Authority.

Mr. Reginald H. Pott has been appointed to succeed the late Sir Alfred Baker as a representative of the London County Council on the Port of London Authority. He is vice-chairman of the L.C.C.

Beira Port Improvements.

It is announced that, in regard to the improvements now being carried out at the Port of Beira, in Portuguese East Africa, berths Nos. 1, 3, 4 and 5 at Pungwe Wharf have now been dredged to 33-ft., so that vessels can load to 30-ft. at these berths. No. 2 berth is still restricted to 28-ft.

Newport Harbour Commissioners.

At the recent annual meeting of the Newport (Mon.) Harbour Commissioners, Captain Edward John Spurrier was elected chairman for the ensuing year and Councillor W. Harold John, vice-chairman. Mr. M. G. H. Dunn, the outgoing chairman, received a cordial vote of thanks for his services.

Inter-Allied Visit to the Port of London.

On June 17th, the Port of London Authority entertained a party of representatives of the Allied Nations (Brazil, China, Czecho-Slovakia, France, Greece, Holland, Norway, Yugo-Slavia, Belgium, Ethiopia, Poland and the United States of America) on an official visit to the docks of the Port of London. The party, which was accompanied by Captain Sir Ion Hamilton Benn, a member of the Authority, representing the chairman in his unavoidable absence, sailed down river from Westminster Pier to the Royal Docks, whence after luncheon, they returned up-river, visiting and inspecting other groups of docks en route.

Colombo Port Commission.

Sir John Tarbat has resigned from the Colombo Port Commission of which he has been an unofficial member since 1929. He was chairman of the Ceylon Chamber of Commerce from 1932 to 1940. At a recent meeting of the Commission, the chairman (Mr. A. N. Strong) paid a tribute to the services which Sir John had rendered to the Board. At the same meeting congratulations were tendered to Dr. R. Saravanamuttu, until recently a member of the Commission, on the conferment of a knighthood, and to Mr. T. A. Owles, the harbour engineer, who has been made a Commander of the Order of the British Empire.

Suggested Revival of the Cinque Ports.

A movement is on foot at Sandwich, one of the original "Cinque Ports" on the South-east Coast, to obtain recognition of status in any scheme of reconstruction under local government. The other ports have been invited to join in representations to the Minister of Town and Country Planning setting out the historical prestige of the Cinque Ports and the desirability of the retention of their corporate status.

Sandwich, which has a population of about 3,000, was one of the chief naval ports and harbours of England in the Middle Ages, but its harbour became silted up in the sixteenth century. The town is now some miles from the sea. Agricola sailed from Sandwich, round Caledonia and back to Sandwich, proclaiming for the first time that Britain was an island.

Construction of Sea Defence Works*

By CHARLES E. FELLOWS, A.M.Inst.M. & Cy.E.

IN most works of sea defence it will be found that the greatest opposition to smooth running construction will come from the sea itself. The wise engineer will therefore endeavour to work in collaboration with the sea and not attempt to defy it in Canute fashion. For this purpose he will acquire a knowledge of its many movements and, although this alone can be the study of a lifetime, it is possible to condense some of the more important theory, having a direct bearing upon marine construction, as follows:—

Tides

There are several theories concerning tide production, of which those of Newton, Airey and Laplace are foremost, but the basis of most theories is that the moon and sun are the prime causes of the action and that the ranging of the tides is relative to the movements of these bodies.

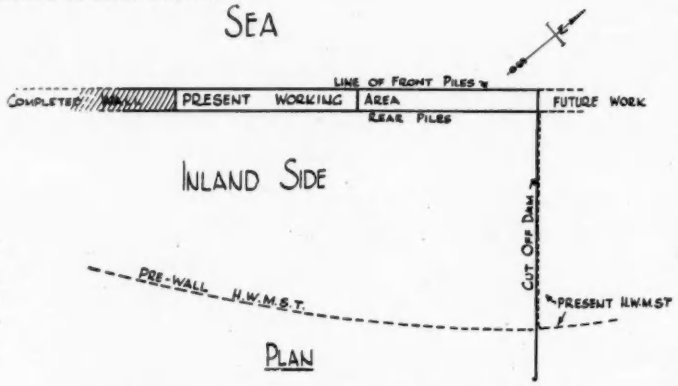


Fig. 1. Showing cut-off dam to prevent inland flooding.

Spring Tides

When the moon and sun are in conjunction or opposition, i.e., diametrically opposed to each other on the same or opposite sides of the earth, the condition of spring tides is produced. These tides occur at approximately new and full moon and are the highest of the lunar month. In actual fact the highest tides usually occur a little after new and full moon and the lapse interval between these dates, which is a constant for each tidal area, is termed the age of the tide. It varies at different parts of the coast from one day in some areas to two-and-a-half or more in others.

Equinoctial Springs

At the equinoxes (March 21st and September 23rd) the sun and moon, by virtue of their relative positions with the earth, exercise their greatest influence upon the tides, and exceptionally high tides are experienced.

Neap Tides

These are the smallest tides of the lunar month and occur when the moon is in quadrature. The same age intervals occur in neaps as in springs.

These very elementary notes serve as an introduction to this paper, but it should be realised that it would be more than unusual for an engineer engaged upon marine works not to be thoroughly acquainted with the local tide tables published for his area. These tables are invaluable in ascertaining and estimating the probable working hours per day for any works.

The following notes will serve as a guide to the construction of various types of sea defence works and some of the points mentioned below will be discussed:—Plant, materials, site preparation and setting out, test piles, damming, excavation, concreting and finishing. It will be convenient to deal with these in the order given above and with regard to the first item of plant, this may be expanded as follows:—

*Reproduced by permission from *Civil Engineering*.

Administrative Plant

An office block will be required for the resident engineer and clerk of works, with accommodation for a small technical staff, clerk, timekeeper, storekeeper, etc. This block may be conveniently constructed in timber, on brick supporting foundations, or it may be of the Nissen hut type. This latter type requires good protection against rusting in the salt atmosphere, if it is intended for it to remain on the site for a considerable length of time. The offices should be in a central and accessible position with a good view of the site if possible. Care and thought should be given to their siting so that removal is unnecessary until the works are wholly completed. It is essential that a telephone and all other services be installed, together with office equipment. The block should also be capable of housing plans, instruments, field testing gear for materials, etc. For convenience, the contractor's offices, and also his small stores and workshops, should be planned around the main office. The pile yard may be situated near by, as also the timber stores, carpenter's shop and mill, steel store and barbending plant. The whole layout should be given good attention and the site should be considered as a well-designed factory plant and not a jerry builder's yard. It is an advantage to construct a substantial temporary road to the site.

The storage and siting of the materials for making concrete for the wall will be described at a later stage, but it should also be considered in the initial stages of setting up the office equipment, etc., described above. Combined planning is necessary in order that the needs of one do not interfere with those of the other.

Transport

Transport which will probably be required on the contract will consist of motor wagons, petrol locos. on jubilee tracks, skips, wagons, bogies, pile bogies, etc., light hand carts and barrows. Since it is probable that the motor wagons will have to run over sandy surfaces the possibilities of " bogging " must be considered at every stage. Nothing is more costly and wasteful than entrenched lorries being idle for an hour or so each day, together with the accompanying breakages of springs, etc. Oversize tyres are a part prevention, but sleeper roads are probably the most satisfactory method of avoiding the trouble. It is suggested by many that sand forms a good motor surface, but after several days usage with heavy loads the reverse conditions is brought about. Rubber-tyred wheelbarrows, which are now almost standard equipment, should also be used in order to provide easy movement on the shore.

Mechanical Plant

This will be comprised of compressors, small concrete mixers other than the batch mixer, scrapers and bulldozers as required, and pumping plant. With regard to those, the main points to be noted are that in addition to the main batch mixer which will be used for the wall proper, a smaller mixer may be used to advantage for making the piles and other pre-cast units, such as any special steps, edging blocks, etc. The pumps which will no doubt be required may be petrol or electric, and should be capable of dealing with all water percolating into the working trenches. A heavy duty pump should be earmarked and kept in reserve in case a water-logged trench is caused by accidental flooding or by heavy gales. The danger time for this flooding will no doubt be the winter months.

Cranes and Pile Drivers

Although these fall into the category of mechanical plant, a special paragraph has been given to them since these items of equipment need to be specially chosen for the works. Cranes should be capable of lifting all types of material from pipes to piles and their attachments should be selected with care and forethought for their duties. Mobile cranes on caterpillar tracks will be most useful and the working length of the jib should be considered in conjunction with the lifts to be obtained, since it may be necessary to lift materials over high temporary pile dams whilst

Construction of Sea Defence Works—continued

the crane itself remains on sand level. The possibility of utilising the jib as a pile frame carrier should also be considered in the works. Pile drivers will probably require two types of hammers, one for steel piling and the other for concrete piles. For steel pile driving a McKiernan-Terry double acting steam hammer, working at 90 lbs. per square inch and giving 300 blows per minute, will no doubt prove satisfactory on works of reasonable size, whilst for concrete piles a single action steam hammer will be required. More will be said about piles and piling later.

Materials

The majority of the materials on the site will be those used in the production of concrete and these may be apportioned out to the pile yard, pre-casting yard, and main mixing plant. It is advisable to have the main mixing plant on a site apart from the general plant since handling, loading, grading, etc., is simplified considerably where there is ample working space. Also the dust, dirt and noise which generally accompanies operations is of little nuisance to the offices and workshops when the sites are spaced well apart. The choice of materials will depend upon the specification for the works, but one or two points are of interest; for instance, coarse shore material and sand should not be used as concrete aggregate. Similarly, site water should be avoided for use in mixing and it is always the wisest policy to obtain mixing water from mains. Cements should be to British Standard Specification and certificates should be called for as required. Site tests of all materials should be made regularly and the results recorded, and for this purpose cement testing apparatus should be provided as suggested in the paragraph concerning office accommodation. The specification regarding mixing should be rigidly adhered to and every care should be taken in the process. In marine works disintegration and chemical attack is generally the main cause of failures and if reinforcement is used in the work, the action of water upon the steel at places of disintegration is serious indeed. The concrete produced should be dense and impermeable and should be well punned and rammed when placed. The curing of the concrete is also important and air or fresh water only should be used. Sea water and beach sand should be carefully excluded from the concrete in the curing stage and should an accident or gale cause sea water to flood any fresh concrete, pumping must be commenced at the earliest opportunity. As a further aid to good work, construction joints should be reduced to a minimum.

Some authorities favour aluminous cements as being specially resistant to the chemical attack of sea water and much may be said in favour of these products for special or difficult work. For ordinary concreting work, and where every care can be taken, a rapid hardening cement will be found satisfactory, and although, again, some authorities prefer the admixture of trass in concrete; generally speaking, a slightly richer mix for the surface concrete in contact with the sea will be found satisfactory.

Referring once more to the disintegration of concrete, this may often be caused by water entering any fine cracks in the surface, freezing therein during cold weather and spalling the concrete upon expansion. For this reason reinforcement in marine works should be given perhaps a little more concrete cover than is provided in inland works. The use of " plums " in large masses of concrete is sometimes debated and whilst there is apparently no reason why they should not be used, there are certain precautions that should be observed. These are that plums should be rough and sharp (smooth boulders are not advisable). Also they should be clean and free from marine growths and must be placed in such a manner that they will be well surrounded with concrete. Plums placed too near to a surface are as useless as plums placed too close to each other in the mass, with little or no concrete acting as a " mortar " between them. Construction joints should be keyed in to successive work, and plums (if they are of reasonable size and are sharp and rough) prove successful as keys. Concrete should be well roughened at such joints and pockets may be usefully provided in the surface so that following work will obtain a satisfactory grip. In connection with the " Deterioration of Structures in Sea Water," further reference may be made to a report under this name prepared by the Committee of the Institution of Civil Engineers, and published by His Majesty's Stationery Office.

Site Preparation

This work involves the setting up of all office equipment, assembly plant, etc., as described, plus the more technical operations of setting out, establishment of datum lines, test boring and piling, etc.

Setting Out

This is the first stage of the work and, as will be realised, will require every care. A survey of the site will no doubt be to hand and will provide an accurate guide to the work. From it the line of the wall should be set out in a substantial manner. The tide will limit the hours for this work and will also specify the type of profiles, pins and marks to be set up. It is generally an advantage to set out the complete length of the work semi-accurately

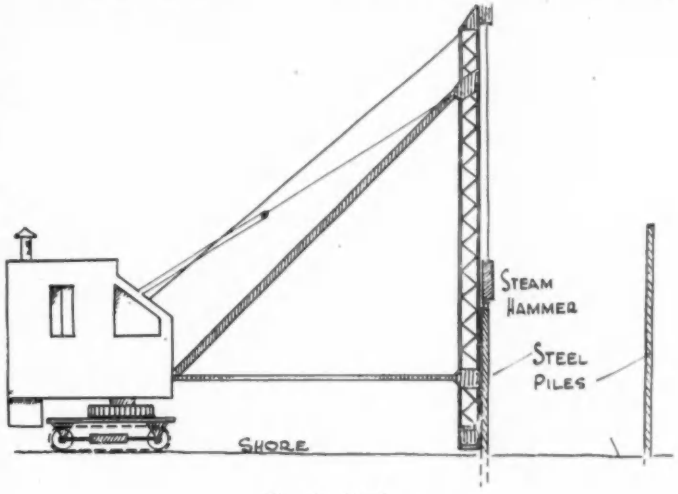


Fig. 2. Jib frame.

and then to make any necessary corrections from this. The practice of proceeding with the setting out as the work proceeds is rather a dangerous one, even though it is often said that a good surveyor never makes a mistake! The corrected line of pins may be replaced by more permanent markings, placed at intervals, and these marks may be deeply driven vertical metal rails or joists. A length of 2-ft. to 3-ft. of the rail should be left projecting above surface level. The line of the works is best set out some 6-ft. to 12-ft. fronting the toe of the wall, clear of all works and on the tidal side of the works. The reason for the tidal face of the works being adopted will be realised from later notes, and also for the reason that the markings will not interfere with the works or get damaged by plant movements. At all times the pins or rails should be subject to careful checking. With regard to levels a primary datum should be laid out at the deep rear of the wall and when checked and agreed should be made permanent with temporary bench mark piers situated at intervals over the whole length. The value of the levels should be painted clearly on the piers and maintained in a clear condition. From these temporary bench marks any working levels can be selected.

It is now an opportune moment to describe a detail of the future, namely, working drawings. At all stages of the work it will be found advisable to prepare, and maintain in a most accurate manner, a complete set of contract drawings. On these should be shown all the various stages of the work together with dates, finished levels, lengths and other details. Variations in the contract should be most particularly recorded and these drawings and notes may be signed and agreed by the contractor's agent and resident engineer. Details of accidents, hold-ups, etc., are also useful. On works of any size it is often of interest to have regular photographs taken indicating progress, unusual features of engineering, etc., as these will form useful items of evidence should any dispute arise at later dates. A small point in connection with working drawings, progress records, etc., concerns the numbering of all possible details of construction, such as the sheet piles of a cofferdam, the concrete piles, any bastions, etc. These numbers may

Construction of Sea Defence Works—continued

be noted on the finished drawings to make reference and identification easy. It is much simpler to talk of " pile 92 " than of " the concrete pile at the toe. 60-ft. to the north-east of the steps."

To return to the more normal sequence of operations, it will probably be necessary at this juncture to drive concrete test piles at recurring intervals along the line of the works, and these should provide a guide to the length of the piles actually required for piling proper. The results achieved will also act as a check upon any trial borings which will have been made during the preparation of the scheme. It is generally a matter for local conditions to decide whether these test piles shall be driven in the virgin shore or behind any temporary dams which are to be built. In

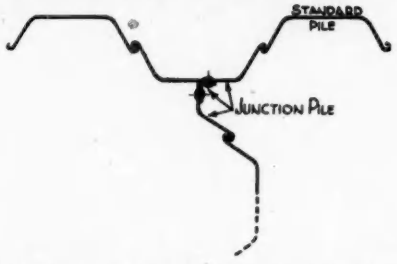


Fig. 3. Junction pile in Standard Panels.

many cases the tests will be best carried out immediately after the construction of the temporary cofferdam as this will have much movement of machinery and will enable driving to be carried out at all stages of the tide.

Progress of the Works

The first work to be done following the setting up of plant and the probable driving of test piles will be to protect the works from the interference of the sea. The method to be adopted depends upon many factors such as the range of tide, strength of the tide and waves in the area, the season, gales and winds, currents, type of surface and sub-surface material. In certain cases it may be that the sea does not come very close to the main works, and in such an instance where the H.W.M.S.T. is well below the wall, elaborate sheet piling is not required. A modified scheme may be necessary when an apron is constructed, and in this case any steel piling used may be left in to shore level thus forming an anti-scour protection. In other cases, where works are below H.W.M.S.T. and where the shore is rocky, steel piles probably cannot be driven in the rock to form a cofferdam and there the work will need to be sufficiently high to prevent the sea water contacting the concrete.

Very often steel piling may be made to serve the dual purpose of (a) cofferdam tide protection and (b) shuttering. In addition the piles will form an anti-scour protection (as mentioned above). In very dry sand, where the tide does not approach near to the works, close boarded, sheeting will probably be needed to retain the sand from the foundation trenches, etc. This generally occurs when the site is near to, or actually in, sand dunes.

Assuming that sheet steel piling in the form of a temporary dam is found to be necessary, this should be set out so that when driven it will form part of the wall foundation shuttering. It may be set out to the actual sea wall line and driving must be carried out carefully to ensure that the whole is perfectly vertical and to a true line. The necessity for the maintenance of a vertical section will be seen when it is considered that the piling will form the false work for the concrete shuttering. The piles must be driven to such a depth that the base of the foundations is well protected and a suitable distance is 4 to 6-ft. below foundation level. The frontal height of the cofferdam may be 6 to 8-ft. above H.W.M.S.T. This freeboard will generally be sufficient to protect the works from the sea in all except very severe gales. The inland or rear sheets of the dam may be shorter than the frontal ones, provided that cut-off dams are provided at right angles to the cofferdam, to prevent the entry of water to the site through the " back entrance " (see Fig. 1). Any shortening of the rear wall, however, should only be decided after consideration has been given to the use of the dam as false work for the shuttering.

The piling may be capably driven by McKiernan-Terry double action steam plant of suitable size. It is not contemplated to give here a detailed description of steel pile driving operations as the whole subject has been very amply treated in the handbook and brochure of the British Steel Piling Co. and other manufacturers; and most engineers will be familiar with these companies' products together with their advice services. A resumé of the operations only will be given and it is essential to note that care and organisation are the keynotes of success. Vertical driving is a comparatively simple operation where a proper pile frame is used, but where this is not possible and the hammer needs to be slung from a crane jib, some form of guide framing and wallings must be used. It is possible to both sling and pitch the piles by means of the crane jib and hammer where a frame is not used, an attachment being provided on the hammer for this purpose. Driving may be often simplified by the use of two types of hammer; a light type to drive to the initial depth, and a heavy hammer to complete and " fix " the pile. In some cases the pile may be driven by an ordinary single drop monkey or by a single acting steam hammer. It is also of interest to note that special frames may be either hired or constructed for fixing to a crane jib and which work is a similar manner to a pile frame (see Fig. 2).

To bring about an economy in driving, piles may be driven in pairs. In this, two piles are matched and interlocked on the surface and are then slung and pitched and provided with a specially designed anvil block which covers both. The hammer strikes against this block and drives both at once. Piling is best driven in panels and the operation is carried out by first driving two or three piles to nearly their finished depth. To the freeboard of these piles is then interlocked a panel of several piles. The last two or three of this panel are then driven to full depth and driving will continue from these until the first ones are reached, these then being driven to final depth. To facilitate pile driving the jetting of the ground at the sides may be resorted to. In this method a high pressure jet of steam, air or water is passed into the ground from a nozzle. The nozzle need only be forced a short way into the ground at the commencement of jetting since after a time it will be found that it is easy to probe the jet alongside the pile as it sinks. Jetting should cease several feet before the final set of the pile.

During the driving of both toe and rear piles, walling, strutting and timbering should proceed and the correct size of the members to be adopted for this work may be either calculated or found from the specially prepared tables issued by manufacturers. Some of the wallings may be made up of R.S.Js' bolted to the piles as this increases the general stability of the whole. The correct placing of timbering is essential to that interference with the concrete shuttering is minimised and if possible obviated. This is par-

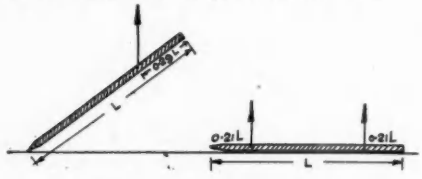


Fig. 4. Pile lifting points.

ticularly necessary where steel repetition shutterings is used and the wallings and struts must be designed so as not to interfere with the individual " lifts " of framework used, but rather to support these as the work proceeds.

Bay Dams

Bay dams are generally introduced at special intervals along the avenue of piles to divide the whole into watertight bays, and for this purpose special piles are used. These bays may be designed to occur at intervals coincident with the expansion joints. To the special piles may be interlocked the bay piles. Similarly, special piles are driven to form the junction with the cut-off dam. Fig. 3 shows the general scheme and a rough detail of the junction piles. To ensure watertightness of the cofferdam caulking should be next applied and this may be done with oakum or with proprietary compounds.

Construction of Sea Defence Works—continued

So much for the work to be done in the construction of cofferdams, and the case of schemes to be carried out above H.W.O.S.T. may now be briefly described. In some cases it may be necessary to lay a very modified sheeting only, as prevention against accidents, but in cases where a reasonably reliable estimate shows that the H.W.M.S.T. will not be exceeded then it may be possible to dispense with sheeting entirely.

Upon completion of pile driving, timbering, and caulking, excavation may proceed and, dependent upon the height of the dam and general circumstances, it may be necessary to build up a ramp backing to the piling as shown in Fig. 5. This ramp will allow the cranes to work at higher levels than the shore level and so reduce the length of jib required. This backing may be constructed in ash or clinker and, again dependent upon the design and circumstances, any back wall drainage should be provided at the time of tipping. The methods of building this backing are many and include end and side tipping from skips running on jubilee track, mechanical excavators and motor wagons working in conjunction, mechanical scrapers, or from skips tipping from jubilee track cantilevered from the back pile dam. When the tip is completed the cranes will have more working space and will also

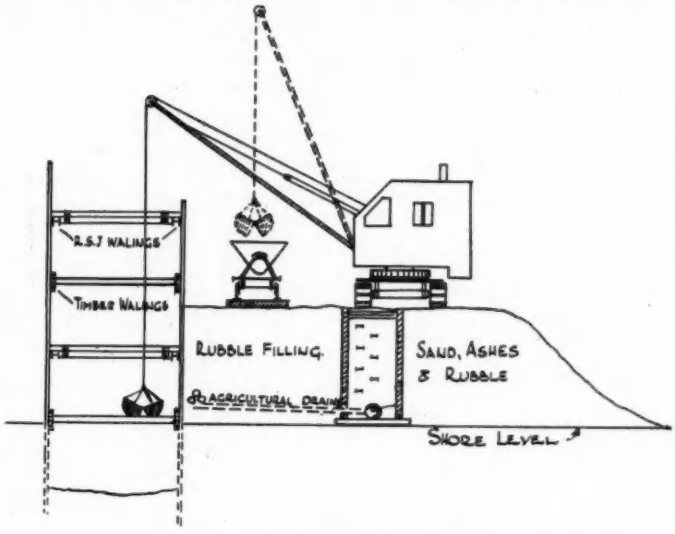


Fig. 5. Excavation backing, etc.

be able to work at higher levels, thus shortening the length of jib required. These cranes may then proceed with the excavation work and a grab bucket system will probably be a satisfactory method of working. Manual labour will be required to trim and level the foundation to final level and the excavation for this may be handled in a suitably sized tipping bucket.

The disposal of the surplus from the excavations does not generally provide a difficult problem as it will no doubt be convenient to use the spoil as backfilling to the wall, thereby building up to higher levels the crane tip referred to in previous paragraphs. Excavation should be carried out to the best foundation level consistent with the depth shown on the drawings. In some cases the poor nature of the sub-surface at the designed foundation level may call for an extra few feet of excavation and within limits this extra excavation can be allowed without materially affecting the stability of the wall It is often a condition of a contract that the last foot or so of material shall not be removed until immediately before concreting, thus ensuring some natural solidity of the base and protection should flooding occur. It has also been suggested that a thin skin of concrete be poured over the whole base area and allowed to set before general concreting is put in hand, in order that the water in the mix of the mass concrete shall be retained and not drained away. This, however, is a debatable point and it is doubtful whether any increase in the nature and strength of the concrete is worth the extra time allowed for setting off the skin base.

Concrete Piles

Before actual concreting is commenced, however, it will be necessary to drive any concrete piles required on the works and this operation should be carried out when the preliminary excavation (not including the last foot or so) has been completed. The piles should be made and cured for about 28 days in an area specially set aside for this work and their lengths will depend upon the lengths of the test piles which will have been driven. The pile yard should be considered to be one of the important features of the scheme and not just a mere incidental to construction. Piles should be marked clearly with the date of their manufacture and although this manufacture may be carried out with the use of the main mixers it is often an advantage to have a smaller mixer set aside solely for pile making. The concrete mix for piles should be such that a very homogeneous product is made. A good mix for long piles is 1:1½:3 at the extremities with 1:1⅝:3½ for the bulk. In short piles it is hardly worth making two mixes and a standard of 1:1½:3 may be used throughout. Piles for marine works are sometimes coated with tar as a protection against chemical action. The pile moulds may be either timber or steel or a combination of both, but the type of the mould will economically depend upon the number of piles required, or upon the availability of the contractor's existing plant. Account must be taken of the curing time and a reserve of moulds must be maintained whilst completed piles are awaiting mould stripping. Normally, with the use of rapid hardening cement, piles may be stripped in a matter of 24 to 36 hours, stacked for curing in 4 to 5 days and driven in 21 to 28 days. In exceptional circumstances piles may be driven in 7 to 10 days, but the longer they may be cured the better.

Handling Piles

The handling of concrete piles from the stacking stage onwards should be carefully carried out, as the piles are stressed to higher limits during handling than when working under load. Mr. C. Reynolds in his admirable book *Concrete Construction* stresses this point, and advises that piles be lifted in accordance with the principle shown in Fig. 4. Holes for lifting may be made in the pile during construction. The piles may be conveyed to the site of driving by tractor, lorry or railway bogies and may be lifted from these by the pile-driving apparatus or by convenient crane. They are driven with similar precautions to steel piles and pile frames may be used where working room allows. If there is difficulty in using a standard pylon type frame due to lack of working room then a crane with vertical guides fixed to the jib may be used, or alternatively the pile my be pitched and held erect with stay wires. Where this latter method is adopted, a system of guide timbers will probably be necessary to ensure straight driving; these guides may be a modified type, similar to those described for steel piling. The pile, when pitched, is driven by a free falling cast iron monkey which is lifted by hand or mechanical means; or by steam hammers such as the McKiernan-Terry single-acting steam hammer. For light piles the double-acting hammer is often found suitable. The important point to note in connection with piling is that a rapid hammering with light blows is preferable to slow and heavy hammering. The height of drop is also important and generally speaking should not exceed 4-ft. 6-in. To obtain results consistent with those achieved with the trial piles it is advisable that the same weight of hammer and same height of fall be used. The ratio of hammer weight to pile weight is generally ranged between equality and one third, and common weights are 1 ton to 3 tons with 3-ft. drop. A speed of 30 to 40 blows per minute giving a 1-in. set over the last 10 blows is also a common specification. Concrete piles should be capped with a cast steel helmet during driving with a wooden dolly inserted in the upper part of the helmet to take the blows. Dollies may be 4-ft. long and can be used until 2-ft. only is left, before discarding. Elm, hickory and oak are the timbers often specified for this work. Sawdust (or wood shavings) packing is placed between the helmet and head to protect the pile from the spalling. After a pile has been driven to its correct depth, and set, the head should be cut off at a suitable height above the foundation level, whilst in addition the upper 2-ft. of the projecting pile should be stripped to expose the reinforcement. This reinforcement is then

Construction of Sea Defence Works—continued

re-modelled to bond with the main foundation concrete. A common height for pile cutting is 5-ft. above foundation level. If a pile is found to be too short it may sometimes be lengthened *in situ* by first trimming back the concrete to expose the reinforcement and then building up the reinforcement and concrete in a vertical extension mould. This process is not approved by many, but it has often proved satisfactory, nevertheless.

Concrete Pouring

Pouring of the concrete to the foundations may proceed when the final excavation and piling has taken place and the method of mixing, conveying, and placing the concrete is worthy of discussion at this juncture. On sizeable works it will probably be most economical to erect a large batch mixer on a suitable site, with a properly organised jubilee track system for conveying and pouring the material on the site of the works. It was mentioned earlier that the frontal concrete should be of a slightly stronger mix than the general mass, and this may be achieved by having a certain number of skips in each train filled with this richer material, say for example the last two skips in each train of 12 skips. These two skips are then tipped last, and to the front of the wall. Skips may be lifted bodily from their bogies by crane and tipped by means of a rope and hook. In cases where a wall with stone facing is to be erected, these stones should be laid first in lifts not exceeding 3-ft., thereupon being left to set. Temporary supporting timber should then be erected and the concrete then poured. Where no rear pile dam is constructed it may be possible to bring concrete to the site in skip as before, but no crane will be required to assist in pouring. Instead, the skips may be side tipped into the foundation trench. Again, on smaller works the practice of dry mixing the materials at a central dump is sometimes adopted, whereupon these are conveyed to a travelling plant which moves along the site upon a specially laid track. From this plant the concrete is poured by chute to the required position and as the wall lifts in height, so the plant is gradually brought to this height on timber framing and trestling. Where track and skips are used against a wall with a temporary rear dam the track may be lifted to working height by filling to the back with sand, ashes and other material.

Construction Lifts

A wall is generally built in three or four definite construction lifts, an example being as follows: (a) foundations; (2) lower part of wall; (c) upper part of wall; (d) coping and nosing. On small walls it may be possible to dispense with separate lifts and to construct the wall to its full height in one continuous operation; but where the separate lift method is adopted, requiring special formwork for each, it will be necessary to finish each lift completely and allow it to set off, before the next is commenced. As the top of each lift of shuttering is reached, the concrete surface should be laid in such a manner that a good bond can be achieved when the work commences on the successive lift above. This may be arranged in several ways which include the provision of plums in the surface, and the construction of pockets in the mass, using well greased moulds which can be removed when new work commences. Timber formwork is not considered economical on large works and it is usual to adopt steel repetition shuttering braced and framed with timber or angle joists. Where this type of shuttering is used it may be located into position by rag bolts built into the concrete of the previous lift. The bolts may be burned or sawn off when the shuttering is stripped (see Fig. 6). This procedure may be adopted for the full height of the wall. As the wall grows in height so must the earth backing proceed. At the various bays it will be necessary to provide vertical expansion joints and these often have a " tongue and groove " plan. The wall, when completed, may be stripped of its shuttering and the temporary dam, and in this latter the piles may be burned off at shore level at the front, and withdrawn where possible at the rear. Burnt-off piles may be welded together to form new piles.

Work to be carried out on the wall after this stage, requires no description here and general principles may be followed hereafter.

Reinforced Concrete Walls

The construction of walls in reinforced concrete raises few additional points of procedure to those outlined in earlier notes, and damming of the site will be carried out by similar means, with the exception that in reinforced concrete works the cofferdam is generally set well forward of the toe. This is particularly necessary where a reinforced concrete apron is being constructed in conjunction with the wall and in such a case the steel piling may occur at the toe of this apron, thus forming an anti-scour vertical sheet when burned off to shore level. As before, in cases where the whole structure is above H.W.M.S.T., no damming will be necessary.

It is very essential in reinforced concrete construction that the sea water is completely excluded from the work owing to its adverse effect upon both steel and concrete, and the bars should be well protected against this. In the construction of a wall where the piling is well forward some form of temporary false-work is required to support the shuttering. Also it will be necessary for the back filling to proceed with the wall construction in order to provide the necessary resistance to keep the wall in equilibrium. This filling should be well rammed and brought up in layers of not more than 2-ft. Unless such a wall is of very considerable length,

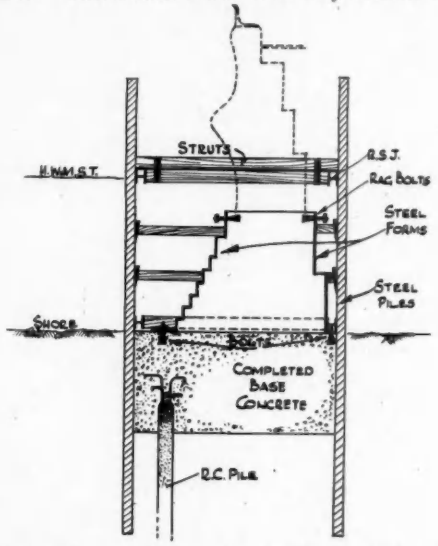


Fig. 6. General section showing frame-work, etc.

a large batch mixer would not be economical and one or more transportable mixers on trestle framing would probably suffice, the trestling forming the necessary support to the shuttering. As with mass walls, the works should be done in lengths consistent with expansion jointing bays; say 60-ft. to 70-ft. bays.

Cliff Work

Against cliffs the work often presents difficulties inasmuch as a cofferdam may not always be driven into the rocky surface of the shore. Consequently much of this work will be tidal. Concrete pouring will no doubt be difficult and it may be necessary to cut away the cliff to form a berm working surface: alternatively, if the cliff is not too high, crane tipping of the concrete may be resorted to, using the cliff top as a working base.

Conclusion

Hard and fast working rules cannot be laid down for marine works, since nearly every site and scheme will vary and present its own individual difficulties. The notes given above are of only a very brief nature and the author realises their many limitations. It is hoped, however, that some interest will have been aroused by their perusal.

Vickers-Armstrongs, Limited, Board.

Vickers-Armstrongs, Limited, intimate the appointment to their Board of Mr. Hubert Thompson and Mr. J. M. Ormston, M.B.E. Mr. Thompson, who for some years has been Commercial Manager at the Barrow Works, has been appointed deputy to Sir James Callender, the General Manager of these works, whilst Mr. Ormston, the Shipbuilding Manager at Barrow, has been appointed General Manager at the Naval Yard, Walker-on-Tyne.

Harbour of Ceará (Fortaleza), Brazil

Progress of Development Works

The following account of the development works in progress at the new port of Ceará, or Fortaleza, on the North-east Coast of Brazil, has been sent by a correspondent of *Lloyd's List* to that Journal, from a recent issue of which it is extracted.

Construction work on the new port of Ceará is now considerably advanced and there are possibilities of it being used in the near future. The work was started in August, 1938, by the contractors, the Companhia Nacional de Construçao Civil e Hidraulicas, the site finally chosen for the new port being the natural shelter formed by the spur of land running out to the Mucuripe Lighthouse. This spur, which extends roughly at right angles from the general contour of the coast, is composed of a low reef on which very high sand dunes have formed almost right up to the shore and is about six miles from the present port.

A general outline of the new port is as follows: A semi-circular breakwater extending in a North-westerly direction for 1,400 metres from the Mucuripe Lighthouse will provide ample shelter for the quay and anchorage, the prevailing winds and currents being from the South-east. Two lateral walls or causeways jut out at right angles from the spur already mentioned, and parallel with the breakwater. The outer wall, which is nearer the breakwater, has a length of 340 metres and the inner one has a length of 240 metres, both walls being 400 metres apart. These two walls will be connected with the quay, which is being constructed with a double set of reinforced concrete tubes braced with reinforced concrete beams, and will be 400 metres long. As an extension of the inner wall there will be a secondary quay 100 metres long connecting this with the main quay.

The pool formed by the causeways and quays will be filled in by the material obtained from dredging the channel and the face of the sand dunes. Warehouses, railway sidings and tracks, etc., will be constructed on the land thus reclaimed. There will be 8 metres of water at the main quay, while the depth of water at the secondary quay, which is intended for the use of small craft and lighters, will be 4 metres. Some 918 metres (about three-quarters) of the breakwater has now been completed. The main quay is expected to be finished by the end of December this year.

It is now thought that the whole of the new port will be completed by May, 1944. In the meantime the Government is considering using part of the port next December for passengers and cargo so as to relieve congestion and difficulties of loading and discharge at the present pier, but in order to do so it will first be necessary to dredge the channel and improve communications between the port and Fortaleza (Ceará) by extending tram and omnibus services. Cranes will be erected on the part of the quay already constructed.

The usual difficulties of building a port where there are shifting sands have shown themselves here. While the breakwater was being built considerable erosion of the coast occurred to the north, between Mucuripe and Fortaleza, resulting in the destruction of a number of houses and cocoa palms. With the extension of the breakwater it is anticipated that the current will be diverted further out, so that if the erosion still continues this will occur further up the coast. To stabilise the dunes at the back of the port, rows of low fences, made of palm fronds have been constructed, with coarse grass and creeper weeds planted in between. This method of holding down movable sands is proving very satisfactory.

The plan of the new port will allow for very considerable extensions. The distance from the outer lateral wall to the breakwater is 1,200 metres, and this will permit of a like extension of the main quay on this side, while there is room for an extension of the quay for a further 100 metres on the opposite side.

Publication Received.

The Brush Electrical Engineering Co., Ltd., of Loughborough, Leicestershire, have issued an illustrated leaflet descriptive of a new electric industrial truck of 2-ton carrying capacity which they have introduced for service. Fully loaded, it can travel 5 to 6 miles per hour and the battery is capable of a day's normal work on a single charge.

Notable Port Personalities

XXXVI—Mr. H. Giles Walker, J.P.

Mr. H. Giles Walker, chairman of the Dundee Harbour Trust, was educated at the High School, Blairlodge, at Edinburgh University and in Switzerland. In 1893, he joined the family firm of Harry Walker & Sons, Ltd., jute spinners and manufacturers, of which later he became a director. In 1922, Messrs. Harry Walker & Sons became one of the constituent firms of Jute Industries, Ltd., and of this undertaking Mr. Walker has been a director since its inception.

Mr. H. GILES WALKER, J.P.

Mr. Walker was first elected to the Dundee Harbour Board in 1911, as a representative of the harbour ratepayers. His membership has been continuous ever since and in November, 1932, he was elected to the office of chairman. During his tenure of office a number of improvements have been carried out in the port, the most important being the construction of the King George V Wharf on the river front, which provides the best deep-water berthage and warehouse accommodation on the East Coast of Scotland.

Review

Facts about British Railways in War-Time, 1943. Price: one shilling, net. Issued by the British Railways Press Office, Waterloo Station, London, S.E.1.

At first sight, it might seem somewhat incongruous to review a railway publication in a Journal devoted to port affairs, but the affinity, though not superficially evident, is nevertheless very close. It was mentioned in our preceding issue, that British Railway Companies own a preponderant share of the dock installations of this country. To no small degree, then, port and railway affairs are intermingled.

This booklet of 64 pages, with its profuse illustrations, describes the important and essential part which railways play, and have played, in the movement of troops, munitions and supplies, during the past three-and-a-half years of war; and a very entertaining account it is of transport operations, capably and unostentatiously thought out and carried through by a loyal and devoted body of railway workers, who deserve the highest commendation for their zeal and efficiency.

Naturally, we looked particularly to see what was said about the part played by the railways at the ports which they control, and here we must confess to a feeling of disappointment. There is a sub-section headed "Docks," but the information it gives is scanty, and, in our view, is an inadequate recognition of the great services rendered by the ports of this country, without which the work performed by the railway personnel, valuable as it is, would have been of no avail. We suggest that, in a subsequent edition, a little more notice might be given of the no less praiseworthy exertions of port officials, dock labourers, stevedores and others engaged in handling the freights destined for overseas.

Apart from this defect, we have nothing but commendation for this artistic and well-printed production, befitting the admirable achievements which it portrays, and cordially recommend it to the perusal of our readers.

It should be added that there have been ten previous editions of the booklet, but without illustrations and of smaller size. In its present form, the publication is of standard size with other war time publications and as above stated, profusely illustrated by half-tone blocks.

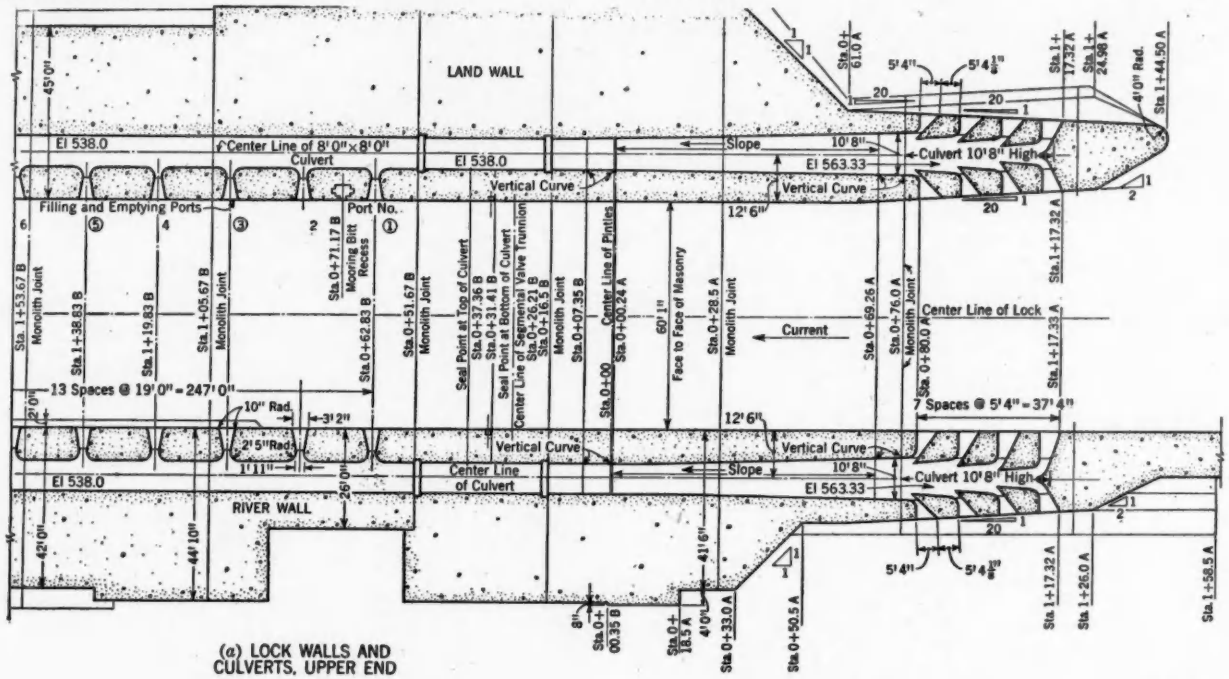
Model Prototype Conformity in Interesting Cases of Lock Construction

By MARTIN E. NELSON, M.Am.Soc.C.E., and JAMES J. HARTIGAN.

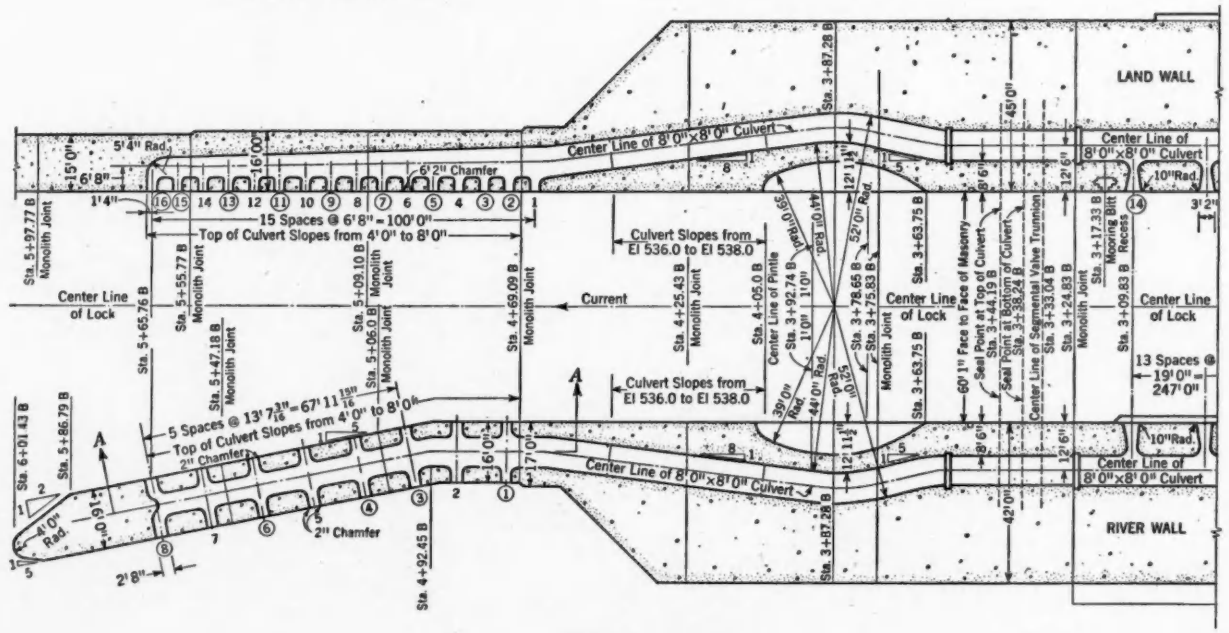
A lock and dam, one of the major projects constructed on an eastern river by the Tennessee Valley Authority (TVA), was designed in 1934. A model of the proposed lock was built and tested at the U.S. Engineer Sub-Office, Iowa City, Iowa, for the purpose of aiding in the hydraulic design of the filling and emptying system. As the Tennessee development continued, other locks were designed and models were used to study special problems and to check the final plans.

The question of the reliability of hydraulic lock models in simulating conditions which would exist in the full-size structures developed with the increased use of this method of design. Accordingly, steps were initiated to test a model of an existing lock in which exact geometric similarity could be obtained. The project chosen for the correlation was a lock, the first project completed in the river by the TVA. A model of the lock was built in December, 1936, and comparisons were made between model tests and a limited amount of prototype test data available at that time. The results of these comparisons were satisfactory, but the prototype data available were not adequate to warrant drawing definite conclusions.

*Reproduced from the Minutes of the American Society of Civil Engineers, October, 1942.



(*a*) LOCK WALLS AND CULVERTS, UPPER END


LAND WALL
Center Line of 8'0"×8'0" Culvert
15 Spaces @ 6'8" = 100'0"
Top of Culvert Slopes from 4'0" to 8'0"
Culvert Slopes from El 536.0 to El 538.0
Current
Center Line of Lock
5 Spaces @ 13'7 3/16" = 67'11 15/16"
2" Chamfer
13 Spaces @ 19'0" = 247'0"
RIVER WALL

(*b*) LOCK WALLS AND CULVERTS; LOWER END

Fig. 1. Project Lock.

Model Prototype Conformity in Interesting Cases of Lock Construction—continued

The division engineer of the Ohio River Division initiated steps for testing a number of prototype locks in two eastern rivers to verify the model tests and to study, under actual operating conditions, the hydraulics of various modifications of the port and culvert system. Tests were made on four locks on one river, and at another eastern river lock. Model tests had been made on only three locks, and this paper will be confined to a discussion of tests made on these three locks and their models.

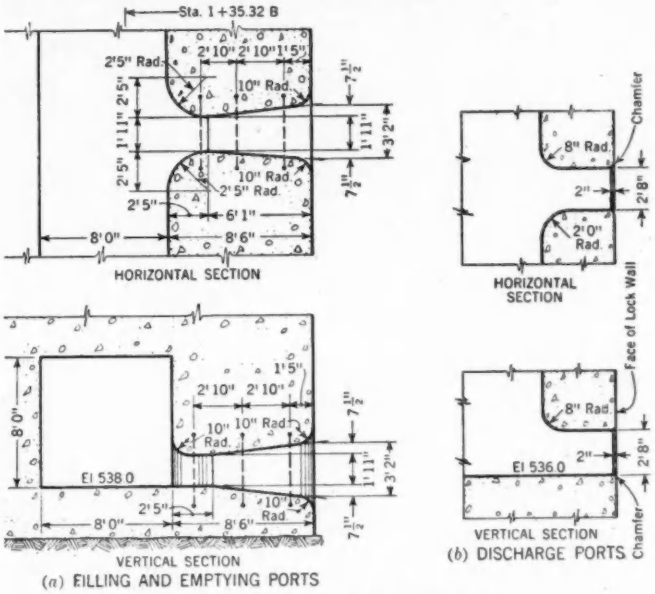


Fig. 2 Sections through Lock Ports.

General Description of Lock Hydraulic Systems

The locks in question are all equipped with the same general type of filling and emptying system. Longitudinal culverts located in the side-walls of the lock open into the upper pool through gallery intakes and into the lower pool through similar discharge sections. Short lateral ports connect the culverts with the lock chamber near the floor. The flow in each culvert is controlled by valves upstream from the first and downstream from the last lateral port to the chamber. In filling the lock chamber the downstream valves remain closed, the upstream valves are opened at a prescribed rate, and water from the upper pool enters the culverts through the intake galleries and flows into the lock chamber through the short lateral ports, the flow of water continuing until the water levels in the chamber and upper pool are

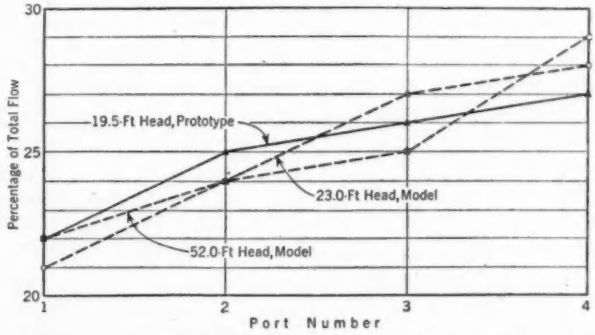


Fig. 3. Distribution of flow through Lock Intake Ports (Constant Flow).

equalised. To empty the lock the upper valves are closed, the lower valves opened, and water in the chamber discharges into the lower pool until their levels coincide.

Fig. 1 shows the essential details of the hydraulic system of one lock. The intake galleries and culverts are designed to effect as uniform acceleration of the flow as possible from the face of the lock wall to the valve section. The ports (see Fig. 2) were streamlined with well-rounded entrance corners to eliminate separation of the jets from the leeward walls. The bores were tapered to effect greater discharge capacity and to reduce turbulence in the chamber by expanding the jets and decreasing their velocity. The discharge section was also designed with a view to obtaining uniform distribution of discharge in the lower lock entrance and to minimise turbulence in the immediate area.

Another lock has a system essentially identical, only enlarged in scale in approximate proportion to the relative dimensions of the structures.

The hydraulic system of still another lock is typical of the designs used in inland waterways locks prior to the use of models in analysing the hydraulics involved in their operation. Deviation from perpendicular lines to effect better hydraulic efficiency was practically avoided. Simplified construction was given primary consideration at the expense of efficiency throughout a lifetime of operation.

Scope of the Tests

The parallel tests that were made in corresponding model and prototype locks will be described in general terms in order to eliminate the necessity of discussing the experimental work performed on each individual structure. Each type of test considered was performed on at least one pair of similar locks and in most cases on all three pairs considered in this paper:

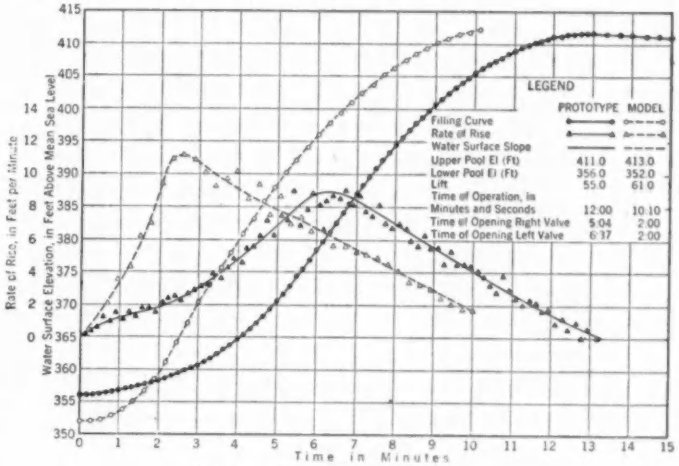

Rate of Rise, in Feet per Minute
Water Surface Elevation, in Feet Above Mean Sea Level
Time in Minutes
LEGEND
PROTOTYPE MODEL
Filling Curve
Rate of Rise
Water Surface Slope
Upper Pool El (Ft) 411.0 413.0
Lower Pool El (Ft) 356.0 352.0
Lift 55.0 61.0
Time of Operation, in Minutes and Seconds 12:00 10:10
Time of Opening Right Valve 5:04 2:00
Time of Opening Left Valve 6:17 2:00

Fig. 4. Filling Characteristics.

(a) The stages near both ends of the lock chamber were observed with respect to time in filling and emptying operation. From these data were plotted filling or emptying curves, rate-of-rise or rate-of-fall curves, and water-surface slope curves, all with respect to time. Comparisons of model and prototype were made on the basis of total time required to complete the the operation, the coefficients of discharge for the entire hydraulic system, the maximum value of the rate of change in stage in the lock chamber, and the rate of decrease in the flow after the maximum had been reached as indicated by the slopes of the rate of rise or fall curves.

(b) Velocities were observed in the ports of the intake section, the manifold section, and the discharge section, and from these data comparisons of the distribution of discharge in the respective sections were made.

(c) Pressure measurements observed at the ends of the culvert transition sections were used in conjunction with volumetric discharge measurements in the lock chamber to determine discharge calibrations and venturi co-efficients.

The primary use for hydraulic models is to provide data for design. As such, the functions of a model are generally completed before the prototype is built, and not infrequently the final design is modified from that used in the model, due to contingencies which had not arisen until the final stages of the design were reached and which were considered too insignificant to warrant the expense of checking in the model. As a result, very few proto-

Model Prototype Conformity in Interesting Cases of Lock Construction—continued

types are built exactly like the models from which their designs were developed. Such differences were found in the locks covered by this study, but wherever possible, corrections will be applied or dimensionless parameters used to validate the desired comparisons.

Comparison of Prototype and Model Tests

Intake Ports.—A primary consideration in the design of the intake sections of one lock was a uniform distribution of flow in the ports. With flow in one direction only, a tapered culvert section could be used. That the design successfully approximated a uniform distribution in the four ports on one side of the culvert, and that agreement existed between model and prototype distributions, are indicated by the graph in Fig. 3. The discharge in the model intake ports varied uniformly from 21.5% to 28.5% and in the corresponding prototype ports from 22% to 27%.

Transition Section.—The rating equation for a culvert transition section, expressed in terms of culvert discharge Q and pressure head differential between two sections $h^{0.5}_{p}$, is based on the Bernoulli theorem; thus:

$$Q = K\ h^{0.5}_{p} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

The co-efficient of discharge for the transition section meter is equal to the ratio of the observed to the theoretical rating. A comparison of prototype and model locks is made, as shown in Table 1, on the basis of the performance of their culvert transition sections as flow meters. The lack of exact geometric similarity in the transition sections of model and prototype accounts for the small difference in the constants of the theoretical rating equations; however corresponding equations and co-efficients for model and prototype are in virtual agreement.

Table 1.—Comparison of Model and Prototype Locks

Description	Rating Equation (Eq. 3) Observed K_0	Rating Equation (Eq. 3) Theoretical K_t	Coefficient of discharge C
Model ...	1,400	1,500	0.93
Prototype ...	1,410	1,525	0.92

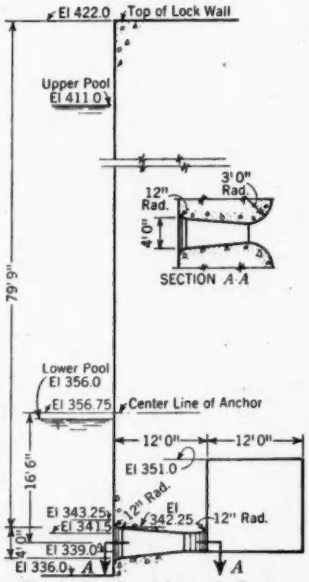
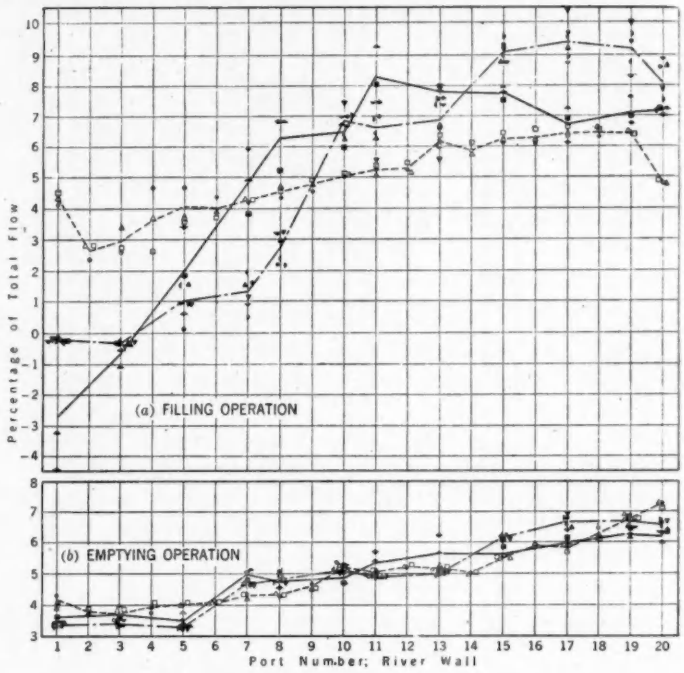


Fig. 5. Sections through Centre Line of Lock-Chamber Port (20 Ports in each Wall).

Lock Stage Tests.—The levels of the water surface in the lock chamber at respective time intervals during filling operations in the model and prototype are shown in Fig. 4. The points defining the filling curves are averages of two stage measurements, one near each end of the lock chamber, observed at each time interval.

The filling curves for the model and prototype locks indicate a considerable difference in the total time of operation and in the form of the filling curves. There were 2 factors which materially affected the results of these tests—one a difference in construction of the lock-chamber ports (Fig. 5), and the other a difference in the time of opening the culvert valves. In the model the total cross-sectional area of the lock-chamber ports at the smallest section was 125.0 sq. ft. per culvert, whereas in the prototype the corresponding areas were 145.0 sq. ft. in the river wall and 147.8 sq. ft. in the land wall. The culvert valves in the model were opened in a time corresponding to 2 min. in the prototype, whereas in the filling test shown the right valve of the prototype required 5 min. 4 sec. to open, and the left valve 6 min. 37 sec. A third factor which also affected the filling time was a difference in the lifts. In the model a lift of 61-ft. was simulated, whereas in the prototype 55-ft. was the maximum difference in water levels existing during the period of the tests.

If the two filling curves shown in Fig. 4 were matched at the instant when the corresponding locks were full, it is noted that they would follow approximately the same path for the period after the valves were completely open. The larger throat area in the prototype lock-chamber ports, which tended to increase the efficiency of the prototype over that of the model, appears to have been offset for the most part by the larger and more efficient divergence angle in the model ports.



Description	Average of Three Heads[b]			Average of Six Heads[b]						Average of Three Heads[c]		
	◆	▲	■	▼	▲	◀	●	▶	▼	□	△	○
Head, in feet	50	45	40	35	30	25	20	15	10	40	30	22
Discharge,[a] in Cubic Feet per Second:												
(a) Filling operation	..	..	..	6,080	5,630	5,200	4,650	4,030	3,320	6,310	5,290	4,64 0
(b) Emptying operation	..	..	..	4,370	4,430	4,220	3,770	3,270	2,670	4,670	4,050	3,47 0

[a] Discharge refers to flow into, and out of, lock chamber through the ports in the river wall. [b] Prototype. [c] Model.

Fig. 6. Distribution of Flow, Lock-Chamber Ports.

The maximum rate of rise or fall of the water level in a lock occurs shortly after the culvert valves are fully open. Because of the difference in time of valve operation, the rate-of-rise and rate-of-fall curves for the model and prototype of one of the locks differ considerably. The maximum rate of rise in the model was 11.1-ft. per min. at 2 min. 35 sec., and in the prototype it reached 9.0 ft. per min. at 5 min. 25 sec. In a manner similar to the filling curves, the rate-of-rise curves for model and prototype follow nearly parallel paths after the peak rate has been reached; the average slope of the curve for prototype is 1.40-ft. per min.^{2}, while that for the model is 1.24-ft. min.^{2}.

The differences in construction details and valve operation, noted in the discussion of the filling tests, apply also with respect to the emptying tests. However, the larger port area and smaller lift existing in the prototype, tending to reduce the emptying time, were practically offset by the longer valve period. The emptying time in the prototype was 13 min. 18 sec., whereas in the model it was 13 min. 29 sec. The dissimilarities in construction details of the two structures make comparisons of the filling and emptying characteristics unsatisfactory.

Model Prototype Conformity in Interesting Cases of Lock Construction—continued

Lock-Chamber Ports.—Model tests have indicated that longitudinal slope of the water surface in the lock, such as was created by surges or by the energy change from kinetic to potential accompanying the decrease in velocity of flow from one end of the lock to the other, is the primary factor that influences movement of a vessel during lockage. Improper operation of the valves and uneven distribution of discharge in the ports of a side culvert system will promote surging in the lock; and, once started, surging will continue throughout a considerable part of the filling period. It is important, therefore, that the filling controls be operated so as to eliminate a sudden inrush of water at the beginning of the filling period, and that the system be designed to distribute the lockage inflow evenly among the lock-chamber ports.

From the port velocity tests made in the model and prototype locks, distribution-of-flow graphs for the ports in the right or river wall for the filling operation were plotted as shown in Fig. 6 (a). The flow distributions in the model and prototype differed considerably, due largely to the dissimilarity of the ports. In earlier laboratory experiments it was found that the distribution of discharge from the ports during a filling operation was influenced to a large extent by the value of the cumulative cross-sectional area of the lock-chamber ports at the smallest section. When the port area exceeded a certain value, the shape of the hydraulic gradient was changed so that during part or all of the filling period water would flow from the lock chamber into the culvert through a number of the ports at the upstream end of the manifold. The prototype port area exceeds that of the model by 16% in the river wall and 18.2% in the land wall. Excess area in the prototype is equivalent to that of three ports. The effect of the excess port area in the prototype is indicated in Fig. 6 (a). Discharge through ports 1 and 3 was reversed, flowing from the lock chamber into

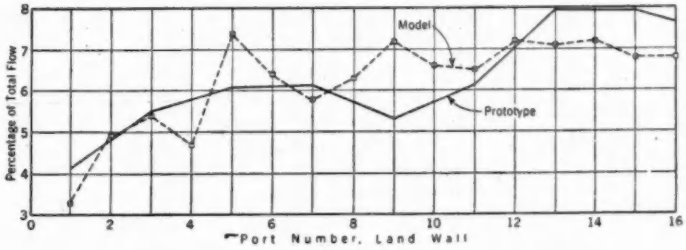


Fig. 7. Distribution of Flow, Discharge Ports (Emptying Operation).

the culvert during the entire period of the filling operation, and, although the flow in port 2 was not measured, it undoubtedly was negative also. Therefore, the distribution patterns in the model and prototype manifolds cannot be correlated.

A very close similarity in the flow distribution in the model and in the prototype during emptying operations is shown in Fig. 6 (b). The distribution flow through the ports was only slightly affected by variations in head, and the discrepancies in port dimensions in the prototype had less effect in the emptying than in the filling operation, undoubtedly because the flow in the venturi-shaped ports was converging instead of diverging.

Velocity in Discharge Ports.—The discharge sections of one of the locks, with the exception of slight differences in a few dimensions, were constructed like the model. Flow conditions during the first part of the emptying operation differed in the two structures, but after the valves were opened completely, distribution of the flow from the ports was found to be quite similar.

In Fig. 7 is shown the distribution of flow from the discharge ports in the land wall of the model for a head of 39-ft. The curve for the prototype shows an average distribution for four heads (25-ft., 21-ft., 15-ft. and 10-ft.), all of which occurred after the valves were open and flow conditions were relatively stable.

These curves for model and prototype are similar in having the same general trend of larger discharges in the downstream ports. The increase in the discharge for each successive port downstream is not so orderly in the discharge section (which has a culvert of variable area) as it is in the lock-chamber section which has uniformly spaced ports and constant area culvert. The percentages of culvert flow carried by the eight upstream and eight downstream ports of the discharge section were 44.4% and 55.6% for both model and prototype, variations between model and prototype having balanced in each half of the section.

(To be continued)

Port of Marseilles

Progress of Development Works

A decree has been issued by the French (Vichy) Minister of Industrial Production and Communications authorising the Marseilles Chamber of Commerce to take up a loan of 42,500,000 francs to cover the cost of port works at Marseilles and its vicinity. The following statement of the works involved and the present condition of matters is extracted from a recent issue of *Lloyd's List*:—

Among the work to be carried out are alterations to Mole A, improvements in the Abattoir channel, the construction of a swing-bridge over the channel between Ferrières and Martigues, and improvements in the signalling arrangements at Port de Bouc, Martigues and the Caronte Canal.

The work to be undertaken on Mole A will make this a modern and commodious pier. Before the present war the Moroccan mail steamers of the Compagnie de Navigation Paquet used to berth at the northern part, and the Algerian and Tunisian mail steamers of the Compagnie de Navigation Mixte berthed at the southern part. During the bombing in June, 1940, its sheds were demolished and is now little more than a clear area having no fixed cargo-handling equipment. Since the armistice between France and the Axis it has been used for the coal traffic.

The narrowness of the Abattoir channel practically prevented modern vessels from gaining access to the Docks et Entrepôts concession. It consisted of two narrow entrances, 31 metres in width, separated by a pier of masonry 13 metres wide bearing an hydraulically operated steel bridge; this moved very slowly, seriously interfering with navigation, which was particularly active at this point. The narrowness of the entrances made manœuvring dangerous when the mistral was blowing. The new passage will provide a free channel over 100 metres in width, in which the largest vessels will be able to move without difficulty. A steel bridge for heavy traffic will connect the Traverse de l'Abattoir with the Quai du Large. This electrically operated bridge is at present in use at the Bassin de Remisage, and will be moved to the Bassin National as soon as progress with the work permits.

With regard to the Pont de Ferrières at Martigues, a start has already been made on the proposed work, the infra-structure being under construction. The provision of a lighting system between Port de Bouc and Martigues and along the Canal, will enable traffic to be carried on at night without danger along a route which, after the war, is certain to carry a large volume of traffic, since it gives access to the Etang de Berre, which is to become an enormous oil depot basin.

Port of Dublin Finances.

According to the annual report, a total of £70,110 was received by the Dublin Port and Docks Board last year in tonnage duties. Of this amount, £57,351 came from cross-Channel trade and £8,439 from overseas trade. The figures show increases of £15,000 and £2,000 odd respectively over 1941. The Irish coasting trade at £1,091 is down by £200 approximately.

Dues were as follows:—On inward goods: foreign £17,954, decrease £1,150; cross-Channel £23,387, increase £2,940; Irish £337, increase £168; coal £15,433, decrease £542. On outward goods: foreign £90, decrease £113; cross-Channel £31,444, increase £5,657; Irish £101, decrease £48.

A total of £41,420 was spent on dredging and another £1,300 was allocated to harbour maintenance generally. A sum of £255 was subscribed to hospital, etc.

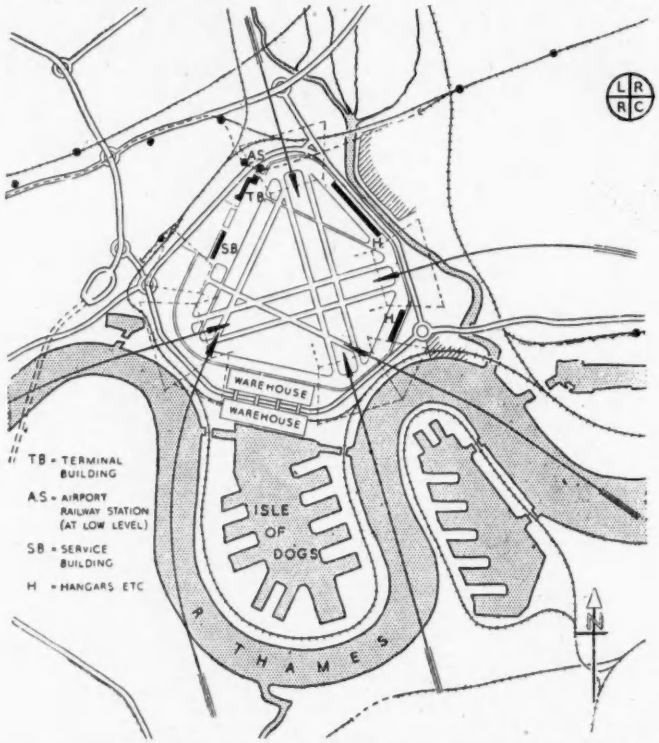
Warehousing receipts were as follow: Tobacco £29,184 (£13,778 increase), whisky, wine, etc., £5,724 (£1,700 increase), grain and general £13,313 (£300 increase).

Reconstruction Proposals for the Port of London

The following extract is taken from a publication issued by the Royal Institute of British Architects, entitled, " Greater London Towards a Master Plan," being the second interim report of the London Regional Reconstruction Committee, May, 1943:—

New Dock Facilities

" The partial discontinued use of some older docks of the Port of London has thrown into relief the inadequacy and out-of-date nature of these port facilities. The docks built for such former services as the tea and wool clippers and the Greenland whalers are now under-sized and, what is more important, are now not well sited relative to the London Plan as a whole. The solid complex of built-up London has grown outwards and has hemmed in the docks; the latter have become, therefore, centres of urban congestion with all the resultant troubles of road, rail and river traffic control and dispersal.



London Regional Reconstruction Committee. Proposed Inner Airport with new docks.

" The scope of the proposals of the L.R.R.C. for the reorganisation of the port may be thought to be too sweeping, but it should be remembered that replanning must be conceived always as a long-term policy which, while forming a basis for procedure, can be adjusted to meet problems at present unforeseen which may arise in the future. It is obviously undesirable to carry out all the proposals at one time; the interruption of sea and river traffic would be too great; but reorganise we must, for the benefit of our future trade and for the general replanning of the eastern centre of London which the opportunity of such reorganisation would permit.

" The docks proposed to be closed are the following: St. Katherine's Dock (opened in 1828); London Docks (1805); Surrey Commercial Docks (1830, with many additions); West India Docks (1802); East India Docks (1806) and Millwall Docks (1868).

" The land thus acquired would be used for the various purposes shown on the Regional Plan. In particular, the Isle of Dogs has been scheduled for new docks. Additional docks are shown on the south side occupying the promontory land between Blackwall Reach and Bugsby's Reach; it is considered that this latter provision would be a second stage in the construction of new port facilities.

" It will be seen from the above that the new proposals are aimed at providing modernised dock service for the Port of London, and to ensure that heavy sea-going traffic shall not proceed further up the Thames than the Isle of Dogs. It will be recalled (see First Interim Report of L.R.R.C., Part III (4), page 14) that it is proposed to embank the Thames down to the Tower Bridge and to substitute for the present bascule bridge an open-road bridge; this is the other half of a general proposal to zone shipping and to reserve the river of the central area for light traffic and for greater urban amenity. The Upper and Lower Pools and Limehouse Reach would still be available under these proposals for smaller sea-going and river traffic, as required for the service of inland waterways and the upper reaches of the Thames.

" The new docks of the Isle of Dogs area would be constructed over a period of years and meanwhile, the existing docks would continue in use. Two main entrance locks are provided for each new dock area; those of the Northern docks (Isle of Dogs) being constructed by enlarging the locks of the South dock of the existing West India Docks; the north wall of the latter would form the northern limit of the new dock basin. An outline of the proposed new docks is shown, diagramatically on Fig. 6.

" The following table is extracted from the Port of London Authority's handbook for comparison with similar figures given below for the proposed new docks:

Name of Dock superseded	River distance from London Bridge Miles	Water Area Acres	Extent of all types of Quay Miles
St. Katherine... ...	·7	10·1	·9
London	1·9	34·9	3·1
Surrey	3·5	134·5	8·9
Millwall	3·6	35·7	2·1
West India	6·1	97·8	4·6
East India	6·7	31·6	1·7

New Docks proposed	River distance from London Bridge Miles	Water Area Acres	Approximate extent of Ship Quays Miles
Isle of Dogs	5¼ average	250	6
Southern-side ...	6½ average	150	4

Legal Notes

Claim against Harbour Authority for Grounding of Ship

A case was decided in the Scottish Court of Session, Edinburgh, on June 10th, which concerned the Aberdeen Harbour Commissioners in regard to an allegation that they were responsible for the grounding, in the navigable entrance channel of the harbour, of a steamship, the *Barra Head*, belonging to Messrs. A. F. Henry and MacGregor, Ltd., of 11, Dock Place, Leith. The accident took place on the evening of February 4th, 1942, shortly after the vessel had left Provost Matthew's Quay, Aberdeen. The plaintiffs alleged that the defendant Commissioners had failed to take reasonable precautions to maintain the channel in a safe condition and had failed to test the depth of water therein; further, that they had failed to warn the master of the vessel and had neglected to send the vessel down at high water.

The defendants contended that the grounding was caused entirely by neglect on the part of the *Barra Head* to keep along her proper course in the channel. They also maintained that, if the vessel had left her berth at the time she was instructed to do so by the harbour master, there would have been ample depth of water for her to proceed in safety.

Lord Robertson found for the defendants on the question of facts. He said that he had formed the irresistible conclusion that the *Barra Head* was off her proper course and took the ground outside the channel limits. In any case, he was clearly of opinion that plaintiffs had failed to make out their case that the grounding took place within the limits of the navigable channed, and, accordingly, he gave judgment for the defendants.

Canadian National Harbours

Financial Returns for 1942

According to the Annual Report of the Canadian National Harbours Board recently submitted to the Dominion House of Commons at Ottawa, there has been a substantial reduction in traffic at the ports administered by the Board during the past year.

Vessels arriving in 1942 numbered 43,432, compared with 47,333 in the previous year and water-borne cargo, inward and outward, amounted to 22,089,516 tons against 29,902,518 in 1941. Operating revenues of the board for the year were $10,416,805, a decrease of $772,624. After taking into account miscellaneous debits and credits and providing for interest and reserve for replacements, the year's operations resulted in a net income deficit of $4,547,935 as compared with $3,514,880 in 1941.

Statements of income for the harbours and grain elevators under the Board's control showed: Halifax Harbour, surplus $232,436 (surplus $53,631 in 1941); St. John (N.B.), Harbour, deficit $243,039 (deficit $547,116); Chicoutimi Harbour, deficit $204,798 (deficit $203,338); Quebec Harbour, deficit $1,561,532 (deficit $1,301,502); Three Rivers, Harbour, deficit $94,029 (deficit $52,049); Montreal Harbour, deficit $1,734,429 (deficit $432,757); Jacques Cartier Bridge, Montreal, deficit $783,519 (deficit $1,015,977); Prescott (Ont.), elevator, surplus $150,355 (surplus $131,105); Port Colborne (Ont.), elevator, surplus $97,858 (surplus $81,739); Churchill (Man.), Harbour, surplus $7,309 (deficit $32,874); Vancouver Harbour, deficit $468,349 (deficit $533,026); Second Narrows Bridge, Vancouver, surplus before providing for instalments of principal $53,792 (surplus $37,287).

The following is a detailed statement of expenditure on Maintenance and Capital Works at the respective harbours:—

Harbour of Halifax

Maintenance.—Ordinary maintenance and repairs were carried out during the year at a total cost of $106,895. The major items were repairs to deck and substructure of piers 3 and 4, Deep Water terminals, re-decking the lighterage wharf at the fish pier, repairs to the marine leg, repairs to deck slab at the fish landing building and regular maintenance of wharves, sheds, cold storage warehouse, elevator, roadways and auxiliary facilities.

Capital Works.—During the year expenditures on capital account amounted to $210,267. Of this amount $20,508 related to ordinary harbour installations, financed from interest-bearing advances to the Board, and $189,759 related to works authorised under and chargeable to War Appropriation.

Harbour of Saint John

Maintenance.—During the year ordinary maintenance and repairs were carried out at a total cost of $99,596. The larger items were dredging berths 5A and 5B to a minimum depth of 20-ft. and 10-ft. respectively, at extreme low tide; the reconstruction of the wooden platform at the rear of McLeod shed; the reconstruction of a portion of Pettingill shed floor; the re-surfacing the Digby shed floor and the painting of a portion of the grain galleries.

Capital Works.—During 1942 expenditures on capital account amounted to $204,938. Of this amount $157,935 related to ordinary harbour installations, financed from interest-bearing advances to the Board, and $47,003 related to works authorised under and chargeable to War Appropriation.

Harbour of Chicoutimi

Maintenance and Capital Works.—During the year ordinary maintenance and repairs were carried out at a cost of $5,674. The principal items were repairs to wharves and railway trackage. A capital expenditure of $146 was made on shed 2.

Harbour of Quebec

Maintenance and Capital Works.—Ordinary maintenance and repairs were carried out during the year at a total cost of $325,358, including $176,492 expended for maintenance dredging at the St. Charles river estuary. The principal items, in addition to the dredging, were repairs to brickwork at the cold storage warehouse; replacing metal siding on part of the grain shipping galleries; caulking masonry joints at Princess Louise inner basin; repairs to Pointe-a-Carcy wharf; railway track repairs; roof repairs to shed 20 and the machine shop; and repairs to the floating crane.

Capital Works.—Expenditures on capital account in 1942 amounted to $24,867, including $21,404 provided from War Appropriation funds.

Harbour of Three Rivers

Maintenance and Capital Works.—During the year ordinary maintenance and repairs were carried out at a total cost of $4,584, including pavement re-surfacing, repairs to water pipe line, numbering berths and sheds, removal of steel plates from the face of Bureau Wharf and completion of survey of harbour boundaries. Expenditure on capital account amounted to $600, for the installation of two fire alarm boxes.

Harbour of Montreal

Maintenance.—During 1942 ordinary maintenance and repairs were carried out at a total cost of $513,770, excluding maintenance on Jacques Cartier bridge on which $24,065 was expended. The larger items were repairs to piers 2 and 3; repairs to wharves at Sections 40 and 42; re-surfacing the lower floor of shed 4; repairs to bin bottoms at elevator B; reconstruction of shipway cradle at Guard Pier; and all rolling stock, electrical, mechanical and floating equipment were maintained in good operating condition.

Capital Works.—During the year total expenditures on capital and replacement works amounted to $514,424, of which $118,080 was chargeable to War Appropriation.

Prescott Elevator

Maintenance.—During 1942, ordinary maintenance and repairs were carried out at a total cost of $17,346. The major items were repairs to wharves, electrical equipment, lofters, conveyors, drying equipment and railway trackage.

Port Colborne Elevator

Maintenance.—During the year ordinary maintenance and repairs were carried out at a total cost of $16,688. The major items were overhauling automatic scales; drying and varnishing motor stator coils on marine leg drive motors; and general repairs to vessel shovel gear, car haul, marine legs, lofters, building structure, inside electrical circuits, vessel loading spouts and railway tracks.

Harbour of Churchill

Maintenance.—During the year ordinary maintenance and repairs were carried out at a total cost of $7,645. The major items were repairs to elevator bin walls, wharf and marine railway.

Harbour of Vancouver

Maintenance.—During the year ordinary maintenance and repairs were carried out at a total cost of $97,959, excluding maintenance of Second Narrows Bridge, upon which $17,146 was expended. The principal items were repairs to concrete bin walls at grain elevators 1 and 3; renewal of the roof of the bin storage at No. 1 elevator; renewal of the approach to the booming grounds; repairs to a section of the main fish wharf float; repairs to the roof of shed 2 at Lapointe Pier and replacement of spout booms at No. 1 Jetty.

Capital Works.—Capital expenditure, provided in part from replacement funds, amounted to $52,338.

The Board records, with regret, the retirement, effective October 1st, 1942, of Colonel A. E. Dubuc, D.S.O., Vice-Chairman and Chief Engineer. During a period of over 40 years, Col. Dubuc rendered distinguished public service with the Departments of Public Works and Railways and Canals, and the National Harbours Board.

The Report is signed by R. K. Smith, Chairman; J. E. St. Laurant, Vice-Chairman; B. J. Roberts and F. W. Riddell.

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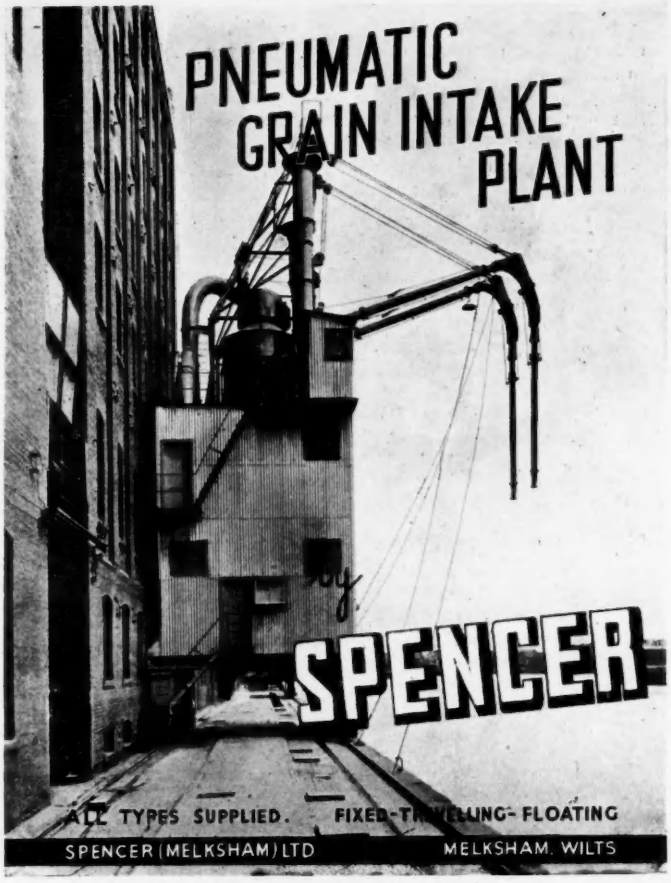

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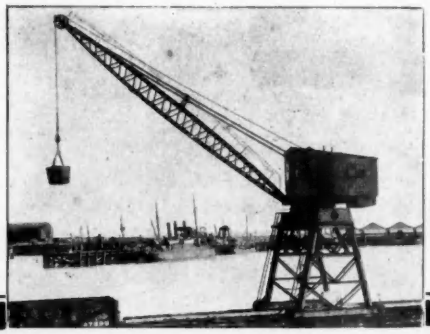

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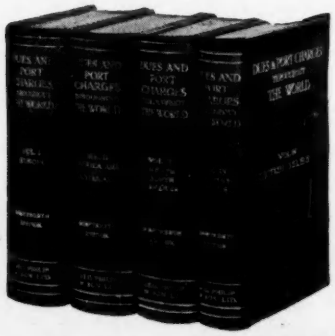

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